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DRAFT -- CITY OF NORTH BEND

SHORELINE CHARACTERIZATION

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1.0 INTRODUCTION

1.1 Background and Purpose

In 2002, the City of North Bend obtained a grant from the Washington State Department of Ecology (Ecology) to conduct a characterization of its shoreline jurisdiction as defined by the state's Shoreline Management Act (RCW 90.58). The purpose of this study is to conduct a baseline inventory of natural and built conditions in the City of North Bend's shoreline jurisdiction to provide a basis for the future update of the City's Shoreline Master Program. This characterization will help the City identify existing conditions, evaluate functions and values of resources in its shoreline jurisdiction, and explore opportunities for conservation and restoration of ecological functions. These findings will help provide a framework for future updates to the City's shoreline environment designations and shoreline management policies and regulations.

1.2 Study Area Boundary

This characterization report includes shorelines along the South Fork Snoqualmie River located in the North Bend city limits, as well as floodway channels associated with the South and Middle Forks of the Snoqualmie River, and any associated wetlands (**Figure 1**, Appendix A). General conditions in areas outside of the City limits, including the City's urban growth area and watersheds draining to the South and Middle Forks of the Snoqualmie River, are also addressed to provide a background context for this report. The South Fork Snoqualmie is a shoreline of statewide significance according to the state's Shoreline Management Act. Under the Act, the City's shoreline jurisdiction includes all areas 200 feet landward of the ordinary high water mark of the mainstem River, areas 200 feet landward of floodways, and associated wetlands. Specifically, the area of shoreline jurisdiction is defined in the Shoreline Management Act as:

"those lands extending landward for two hundred feet in all directions as measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward two hundred feet from such floodways; and all associated wetlands and river deltas (RCW 90.58.030(2)(f).)

For the purposes of this report, this area is shown on **Figure 1** as the shoreline jurisdiction. To evaluate future management options, this inventory also includes a general assessment of land uses (**Figure 2)** and those areas of the City located in the 100-year floodplain of the South and Middle Forks of the Snoqualmie River. Under the Shoreline Management Act, jurisdictions have the option of including areas of mapped 100-year floodplain in their shoreline jurisdiction. This area is shown on **Figure 3** in Appendix A.

The portion of the South Fork Snoqualmie River located in North Bend's city limits extends from River Mile (RM) 4 to approximately RM 1.2 as defined by the distance upstream from the confluence with the North and Middle Forks. The City's shoreline jurisdiction, including the South Fork Snoqualmie River and floodways of the South and Middle Forks, are located in Sections 9, 10, 15, and 16 of Township 23 North, Range 8 East, North Bend Quadrangle and Sections 3 and 4 of Township 23 North, Range 8 East, Snoqualmie Quadrangle.

1.3 Methodology

A number of King County, state, and federal agency data sources, City of North Bend records, and technical reports were reviewed to compile this inventory, including but not limited to the following:

- The state's Salmon and Steelhead Stock Inventory (SASSI); Appendix: Bull Trout/Dolly Varden (1998);
- The Catalog of Washington Streams and Salmon Utilization, Volume 1, Puget Sound Region (1975);
- The Salmon and Steelhead Habitat Inventory and Assessment Project (SSHIAP);
- Washington Department of Fish and Wildlife's Priority Habitats and Species and "StreamNet" databases (2002);
- Meadowbrook Farm Master Site Plan (1999);
- Tollgate Final Environmental Impact Statement (2000);
- South Fork Tributaries Action Plan Phase II Report (2001);
- Channel Migration in the Three Forks Area of the Snoqualmie River (1996);
- East King County Ground Water Management Plan (1998); and
- King County Bull Trout Program, 2000 Bull Trout Surveys (2001).

A number of sources were also reviewed to characterize overall watershed conditions and to assess the ecological function of North Bend's shorelines in this watershed context. Watershed-level condition sources reviewed for this report include:

- The City of North Bend Draft Flood Plan (2001);
- The King County Flood Hazard Reduction Plan (1993);
- The Draft Snohomish River Watershed Initial Assessment (1995);
- The King County Regional Needs Assessment Atlas (1995);
- The Draft Snohomish River Basin Near Term Action Agenda (2001); and
- Soils maps for the area (**Figure 4**).

Other sources of information on land use and cultural resources included the City of North Bend Comprehensive Plan, The Register of King County Landmarks, the Washington Heritage Register, and the National Register of Historic Places. The Washington Office of Archeology and Historic Conservation was also consulted to collect information for this report.

Aerial photographs of the study area were consulted, and staff biologists conducted a reconnaissance field survey of the City's shoreline jurisdiction.

Several sources were used to map the shoreline jurisdiction as shown on **Figure 1** and following figures. River boundaries were created from planimetric mapping completed by King County Surface Water Management from 1993 to 1995. These sources were supplemented with orthophotography developed by NIES Mapping Group in 1995. Floodway and floodplain boundaries were derived from the Special Flood Hazard Areas identified on the Draft Flood Boundary Work Map, dated September 26, 2001 (City of North Bend, 2001b). Finally, wetland locations were mapped based on the June 1991 North Bend Wetland Report (City of North Bend, 2000). For the purposes of this inventory, those wetlands assumed to be associated with shorelines (fall within 200 feet as measured from the top of bank or floodway, or if they are connected to the defined shoreline environment by a surface water connection) are included in the shoreline area shown on **Figure 1**.

Finally, a literature review of recent scientific documents was conducted pertaining to baseline conditions in North Bend's shorelines and "best available science" as defined by the state's Growth Management Act. This best available science review in this report focuses on those functions and values most closely associated with management of shorelines in riverine environments in North Bend, such as frequently flooded areas. As the City reviews its specific policies and regulations relating to other critical areas, additional review of best available science relating to wetlands, streams, fish and wildlife habitat conservation areas, geologically hazardous areas, and aquifer recharge areas will be conducted.

1.4 Report Organization

This report is divided into seven main sections. After Section 1.0, which provides background and introductory information, Section 2.0 discusses the regulatory context for shoreline planning. Section 3.0 focuses on existing land use, zoning and built environment conditions in the City and its shoreline jurisdiction, while Section 4.0 discusses biological resources in the shoreline jurisdiction. Section 5.0 focuses specifically on best available science as it relates to shoreline management. Section 6.0 provides a segment-by-segment analysis of shoreline conditions, and Section 7.0 provides a set of shoreline management recommendations.

Also accompanying this report are several figures that identify the City's shoreline jurisdiction; identify shoreline planning segments; and document various biological, land use, and physical elements. Figures are referred to throughout the document and are contained in Appendix A.

1.5 Study Segments

To categorize distinct segments of the City's shorelines for planning purposes, the shoreline jurisdiction was classified into four segments based broadly on the level of ecological functions provided by each segment, as well as existing and projected land uses. Table 1 indicates the location of shoreline segments. Segments are also shown on **Figure 1**.

Table 1. Shoreline Study Segments

General Boundaries	Segment	Approximate Length (feet)	Approximate River Mile
Snoqualmie Valley Trail Bridge downstream to northern City limits (west bank only)	A	4,040	1.2 to 1.9
Snoqualmie Valley Trail Bridge downstream to northern City limits (east bank only)	B	2,800	1.2 to 1.9
Snoqualmie Valley Trail Bridge upstream to Bendigo Boulevard Bridge	C	4,400	1.9 to 2.8
Bendigo Boulevard Bridge upstream to southern City limits	D	6,600	3.0 to 4.0

2.0 REGULATORY ENVIRONMENT

2.1 City Regulations

CITY STAFF TO PROVIDE

- Chapter 14.10: Critical Areas
- GMA Comprehensive Plan, Chapter 18.02: Zoning
- Chapter 15.40: Flood Development Regulations
- Chapter 19.10: Stormwater Standards, Grading and Clearing (relationship to NPDES and Ecology stormwater program).
- SEPA

2.2 State, and Federal Regulations

There are a number of King County, state, and federal environmental regulations relating to management of shoreline areas in the City, addressing issues such as fish and wildlife species, wetlands, and water quality. The primary state and federal regulations affecting shoreline-related resources are briefly summarized below.

Endangered Species Act: The federal Endangered Species Act addresses the protection and recovery of federally listed species, including fish and wildlife species utilizing North Bend's shorelines during various life stages and for various habitat needs (bald eagle, bull trout). Three sections of the Act potentially pertain to shoreline management: Sections 4(d), 7, and 9. Section 9 of the Act prohibits "take" of federally listed species, while Section 7 requires consultation with the National Marine Fisheries Service or U.S. Fish and Wildlife Service ("the Services") for projects that have a federal nexus (such as permits or funding). Section 4(d) allows the Services to develop rules specifying activities that are "exceptions" to the take prohibitions because they minimize impacts to listed species. Projects such as culverts, berms, dams, stream channel modifications, projects that alter streamflow, bridges, roads, trails, or other projects that could affect a federally listed species may require review under Section 7, or could result in a "take" of a listed species as defined under Section 9.

- Clean Water Act: The federal Clean Water Act requires states to set standards for the protection of water quality for various parameters, and it regulates excavation and dredging in waters of the U.S., including wetlands. In addition to the City's critical area regulations, certain activities affecting wetlands in the City's shoreline jurisdiction may require a permit from the U.S. Army Corps of Engineers under Section 404 of the Act.
- River and Harbor Act: Any work below the ordinary high water mark of the South Fork Snoqualmie River may require compliance with Section 10 of the River and Harbor Act, which regulates navigation in waterways.
- Hydraulic Project Approval: The Washington Department of Fish and Wildlife (WDFW) regulates activities that use, divert, obstruct, or change the natural flow of the beds or banks of waters of the state and may affect fish habitat. Projects in the shoreline requiring construction below the ordinary high water mark could require this approval from WDFW. Projects creating new impervious surface that could substantially increase stormwater runoff to waters of the state may also require approval.

3.0 LAND USE AND "ALTERED" CONDITIONS

The City of North Bend, located approximately 30 miles east of Seattle, encompasses an area of approximately 3.5 square miles. The City is located in the foothills of the Cascade Mountain Range, in the upper Snoqualmie Valley near the base of Mount Si. The City occupies both the east and west banks of the South Fork Snoqualmie River, stretching approximately four miles upstream from confluence of the North, Middle, and South Forks of the Snoqualmie River.

As of 2000, the City's population was approximately 4,750. Between 1990 and 2000, the City's population increased approximately 84 percent, while the land area in its incorporated City limits remained constant (Puget Sound Regional Council, 2001). Some of this growth has occurred in the shoreline area of the South Fork Snoqualmie River and near floodways in the City's shoreline jurisdiction; based on City land use and zoning designations, some additional growth in the City's shoreline jurisdiction is likely to occur.

3.1 Watershed Characteristics and Historic Land Use

3.1.1 Watershed Characteristics

The City of North Bend is located in upper portions of the Snoqualmie River valley, a portion of the larger Snohomish River watershed. At 1,856 square miles in area, the Snohomish River Basin, Water Resource Inventory Area (WRIA 7), is the second largest basin draining to Puget Sound, including the Skykomish, Snoqualmie, and Snohomish River watersheds. This large system is a major contributor of water, biota, and organic materials to the central Puget Sound marine ecosystem (Snohomish Basin Salmon Recovery Forum, 2001). The Snoqualmie River watershed, a portion of which is drained by the South Fork, is a large watershed, comprising approximately 690 square miles and nearly one half of the Snohomish River Basin. The Upper Snoqualmie Basin consists of the combined watersheds of the North, Middle, and South Forks of the Snoqualmie River; these three forks converge upstream of Snoqualmie Falls near the City of North Bend.

The South Fork Snoqualmie River is approximately 31 miles long, extending from its headwaters in mountainous, forested terrain at Source Lake in the Cascade Mountains to its confluence with the mainstem of the Snoqualmie River, approximately two miles north of North Bend. The South Fork Snoqualmie River Basin drains an area of approximately 82 square miles, containing approximately 30 small tributaries, which collectively constitute an additional 81 linear stream miles (Williams et al., 1975). Approximately 75 percent of the South Fork Snoqualmie watershed lies in area managed for forest production or recreation, including private forestlands, and lands managed by the state's Department of Natural Resources, and lands managed by the U.S. Forest Service. This largely undeveloped headwater area helps to maintain hydrologic functions and protect water quality in downstream areas of the watershed (King County, 2001).

Topography in the Upper Snoqualmie Basin is characterized by bedrock ridges, slopes, and valleys of the Cascade Range and foothills (HWA GeoSciences, 2001). Topography in the City limits is generally flat to gently rolling terrain characteristic of the City's location on a valley floor. Elevations in the City range from 420 to 560 feet above mean sea level. Historically, continental and alpine glaciers excavated deep channels into bedrock; these channels were subsequently filled with glacial and alluvial sediment during successive Pleistocene Epoch glacial events. A large lake also occupied the Snoqualmie Valley during post-glacial times.

More recent surface geology in the North Bend area is dominated by alluvial and overbank flood deposits of the Snoqualmie River and generally consists of silt, sand, and gravel, characterizing the City's location on top of a large alluvial fan area. According to drilling records on file with Ecology, the average depth to bedrock in the Upper Snoqualmie Basin ranges from 550 feet near the City of Snoqualmie to more than 700 feet in the center of the valley near North Bend (HWA GeoSciences, 2001).

3.1.2 Historic Land Use

The earliest landscape modifications in the Snoqualmie Valley were associated with the use of fire to maintain prairie resources by Native American inhabitants. During this period, Native Americans inhabiting the valley established trails through the valley and over mountain passes to enable trade with tribes east of the Cascades.

With the advent of Euro-American settlement in the early 1800s, the City of North Bend's development pattern changed to support agriculture and related natural resource uses, such as timber harvesting. During early settlement, much of the valley was forested when the City was incorporated in 1909. Over time, landowners encouraged the harvest and clearing of forests so land could be tilled (City of North Bend, 2001c). Early economic activities included hops and potato farming, mining, transportation support services, and lumber production. During this time, the City's downtown commercial core developed along the east-west route stating with the old Sunset Highway (SR 202), then old Highway 10 (North Bend Way), with residential uses clustered around this core. Rural land uses were scattered throughout the Upper Snoqualmie Valley (City of North Bend, 1998).

In the 1960s, approximately 11,000 linear feet of levees were constructed on portions of the South Fork Snoqualmie River in the vicinity of downtown North Bend in response to flooding events and channel migration. These levees have since prevented the South Fork from overflowing in North Bend except in moderate to large flood events (King County, 1996). Other

structures such as railroad lines and bridges have also affected the migration of the River and its hydrology during flood events. **Figures 5, 6, and 7** compare aerial photographs of the four shoreline planning segments in 1958 (pre-levee construction) with more recent 1995 photographs.

With the completion of Interstate 90 interchanges, the City experienced increased commercial development. This development has included service stations, restaurants, a factory outlet mall, and the Nintendo warehouse and distribution center, all largely concentrated near I-90 on the west bank of the South Fork Snoqualmie River. Future development is likely to continue in the City; however, the extent of this future development is likely to depend on the City's success in securing additional water supply (see Water Resources, below).

3.2 Existing Land Use

Land use in the City and in the 100-year floodplain of the City of North Bend's shoreline jurisdiction includes a mixture of single-family, multi-family, commercial, industrial, agricultural and open space uses. The downtown commercial core is located on the east bank of the South Fork Snoqualmie River along the old Highway 10 corridor (now North Bend Way), reflecting the historic development pattern of the City. Near Interstate 90 south of downtown, newer commercial and industrial development is located along Bendigo Boulevard, between I-90 and the west bank of the South Fork Snoqualmie River. Residential development occurs throughout the City, but predominates on the east side of the River, north and south of downtown, and southwest of the I-90 interchange (Exit 31). North of downtown, the City largely remains in open space, forested, or agricultural land along both banks of the river.

Impervious area in the City's shoreline jurisdiction was estimated by reviewing aerial photographs, land use, and GIS data to examine the distribution of building footprints, parking areas, and roadways. Based on this review, approximately 13 percent of the City's shoreline jurisdiction is comprised of impervious surface. Table 2 characterizes the predominant existing land uses and provides estimates of impervious area in each segment of the shoreline jurisdiction.

Table 2. Land Use and Approximate Impervious Surface Area Coverage by Shoreline Planning Segment

Shoreline Planning Segment	Predominant Existing Land Use	Approximate Impervious Area (%)
A	Open Space, Parks, Agriculture	6
B	Open Space, Single Family Residential	19
C	Commercial, Employment Parks, and Residential	12
D	Single and Multi-Family Residential	18

Source: City of North Bend GIS, 2002.

3.3 Comprehensive Plan, Zoning Designations, and Shoreline Management

The North Bend Comprehensive Plan Land Use Map identifies residential, commercial, resource land, public/quasi-public, and industrial land uses in the City limits, including areas in the 100-

year floodplain and four planning segments (**Figure 2**). Title 18 of the North Bend Municipal Code establishes zoning districts for the City. These districts include two commercial zones (downtown and interchange commercial); neighborhood business; employment parks (Park 1 and 2); low- and high-density residential; and park, open space, or public facilities zones (**Figure 2**).

Chapter 15.44 of the North Bend Municipal Code (Ordinance 823, 1990) establishes the City of North Bend's Shoreline Master Program and Shoreline Environment Designations. Four shoreline environment designations are established by the City Code: Conservancy Environment, Rural Environment, Urban General Environment, and Urban Residential Environment.

Table 3 describes the predominant existing land use, zoning designations, and shoreline environment designations in each planning segment of the City's shoreline jurisdiction (City of North Bend, 1990, 1995, 2001a).

Table 3. Land Use, Zoning, and Shoreline Environments

Shoreline Planning Segment	Existing Land Use	Zoning Designations	Shoreline Environments
A	Vacant, Public / Quasi Public	Employment Park (EP-1), Parks / Open Space / Public Facilities	Conservancy, Rural
B	Vacant / Residential	Low Density Residential	Conservancy
C	Vacant, Resource Land, Residential, Industrial, Commercial (west bank); Residential, Commercial, and Public Land (east bank)	Employment Park (EP-1), Neighborhood Residential (west bank); Downtown Commercial, Low Density Residential, and Park / Open Space / Public Facilities (east bank)	Conservancy, Rural, Urban General (west bank); Conservancy, Urban General (east bank)
D	Residential and Vacant	Interchange Commercial (west bank), High Density Residential, Low Density Residential, Park / Open Space / Public Facilities (east bank)	Conservancy, Urban General (west bank); Urban General, Urban Residential (east bank)

3.4 Parks, Open Space, and Public Access Sites

A number of local and regional parks, open space, recreation, and community facilities provide public access along the South Fork Snoqualmie River in the City of North Bend (City of North Bend, 1995). The City contains over 8,000 linear feet of river frontage along the South Fork Snoqualmie River shoreline in a combination of public lands owned by the City, King County, or public utilities. **Figure 2** identifies public parks and open spaces along the River that provide riverfront access. These include:

- **Meadowbrook Farm:** Meadowbrook is an historic farm property comprising a total of 460 acres in both the City of Snoqualmie and the City of North Bend. Approximately 204 acres are in the northern portion of the City of North Bend, providing approximately

2,000 linear feet of frontage along the west bank of the South Fork Snoqualmie River.

- **Tollgate Property:** Immediately south of Meadowbrook Farm, the area of the Tollgate property within shoreline jurisdiction is owned by King County Parks and proposed to be designated open space. Within the shoreline jurisdiction, the property spans approximately 150 acres, on both banks of the South Fork Snoqualmie River. The Snoqualmie Valley Trail bisects the property. The Tollgate Open Space area provides approximately 3,000 linear feet of riverfront access along the South Fork Snoqualmie River. A portion of Segment A west of the Snoqualmie Valley Trail is in private ownership, bordered by Meadowbrook Farm to the north and Tollgate Farm to the south.
- **Snoqualmie Valley Trail:** Developed along the Burlington Northern Railroad right-of-way, this King County trail extends 36 miles from the City of Duvall to Iron Horse State Park, crossing the South Fork Snoqualmie River in the City of North Bend.
- **Tanner Trail:** The Tanner Trail is a right-of-way along the former Burlington-Northern railroad corridor, along the south side of North Bend Way. City ownership of the right-of-way is limited to the section between Gardiner Creek and Cedar Falls Way and is encumbered with a long-term easement to the Snoqualmie Valley Historical Railroad for operation of a historic railway for most of it's length. The old Tanner right-of-way crosses the South Fork Snoqualmie River just west of downtown and intersects the Snoqualmie Valley Trail east of the City, outside of the City limits but in its urban growth area.
- **Nintendo Easement**: This easement provides public access to use the top of the levy on the west bank of the South Fork Snoqualmie River for a distance of 1,900 feet, between the river and Ribary Creek, for most of the length between North Bend Way and Bendigo Boulevard. While the public routinely uses the length of the route, legal access on the Bendigo end is obstructed by one intervening single-family property with approximately 500 feet of river frontage**.**
- **Riverfront Property:** This city-owned four acre undeveloped open space property has approximately 1,000 feet of frontage along the west bank of the South Fork Snoqualmie River. It is located immediately across North Bend Boulevard from Gardiner-Weeks Memorial Park.
- **Gardiner-Weeks Memorial Park:** This 3.3-acre park has approximately 200 feet of frontage on the east bank of the South Fork Snoqualmie River, and is located off North Bend Boulevard (SR-202). The Snoqualmie Valley Historical Museum, the Farm-Shed Museum, and the Mt. Si Senior Center buildings are all located in this park.
- **New Si View Subdivision Public Open Space:** The New Si View Subdivision Public Open Space has approximately 3,500 feet of frontage, including active recreation facilities (tot lots, picnic tables and paved trails) along the east bank of the South Fork Snoqualmie River in the Si View Subdivision.
- **King County Si View Park:** Located adjacent to the City limits at the intersection of Orchard and Healy streets in North Bend is a public park with picnic facilities and access to the South Fork Snoqualmie River.

Parks and open spaces within the City of North Bend's 100-year floodplain that do not provide riverfront access include E.J. Roberts Park and Torguson Park.

3.5 Levees and In-Water Structures

As previously discussed, approximately two-thirds, or 11,000 linear feet of the South Fork Snoqualmie River bank in the City of North Bend has been lined with a series of levees and revetments. These structures date from as early as 1966 and extend in the City from the Snoqualmie Valley Trail upstream to Interstate 90. At the north end of the City, the Circle River Ranch levee was constructed in 1968 along a portion of the east bank of the South Fork Snoqualmie River (King County, 1996). These levees are under the jurisdiction of King County. In January 1997, the U.S. Army Corps of Engineers determined that both the right and left bank levees along the South Fork no longer provided protection from 100-year floods due to maintenance deficiencies (U.S. Army Corps of Engineers, 1997). In their letter "decertifying" the levees, the Corps suggested evaluation of several factors including embankment and foundation stability, freeboard, closures, embankment protection, seepage, settlement, interior drainage, and closures (U.S. Army Corps of Engineers, 1997).

The County has been maintaining the levees, but resources are limited for regular maintenance (Bean, personal communication, 2002). The City of North Bend is working with the County to pursue feasibility studies for levee modifications; to date, the proposal remains preliminary and unfounded (Bean, personal communication, 2002). Setback or raising of the levees to enhance flood protection and increase channel capacity in North Bend was identified as a high priority in King County's 1993 *Flood Hazard Reduction Plan* (King County, 1993).

Aside from the five bridges described earlier, there are no docks, piers, bulkheads, or other in-water structures in the South Fork Snoqualmie River in the City of North Bend.

3.6 Archeological and Historic Resources

Human use and occupation of the upland river valleys of the Puget Sound Basin is believed to have begun more than 8,000 years ago. In the Snoqualmie River drainage, the Snoqualmie Tribe inhabited villages generally located along the Snoqualmie River. However, following the signing of the Point Elliot Treaty in 1855, European settlement and farming began to dominate the region (Meadowbrook Farm Conservation Association et al., 1999).

A number of sources identify sites having local or regional historic importance in the City of North Bend. These sources include the City of North Bend Comprehensive Plan (1995), The Register of King County Landmarks (2000), the Washington Heritage Register (2002), and the National Register of Historic Places (2002). The Meadowbrook Farm Site, listed in the North Bend Comprehensive Plan as an "Historic Site of Local Importance," is a listed site in the City of North Bend shoreline jurisdiction (City of North Bend, 1995). Evidence of crptocryastiline stone tools, projectile points and fire-cracked rocks have been documented on the Meadowbrook site indicating prehistoric human use of the site (URS Greiner, 1998). The historic Meadowbrook Farm was part of a 1,500-acre hop ranch, with over 900 acres of hops planted at one time, which

flourished in the valley from 1882 until approximately 1894 (A History of the Snoqualmie Valley, Ada Snyder Hill 1970).

The Tollgate Farm, located on the West Bank of the Snoqualmie River upriver from Meadowbrook Farm, is also listed in the North Bend Comprehensive Plan as an "Historic Site of Local Importance" (City of North Bend, 1995). The Indian trail leading from eastern Washington through Snoqualmie Pass crossed a natural river ford on the Tollgate Property. Tollgate Farm was the site of the historic Fort Smalley, built in 1856 by the Second Washington Militia Regiment. The "toll gate" which gave the Tollgate Farm its name, came later with improvements to the road through the site as a route over Snoqualmie Pas (URS Greiner, 1998). This property is located in planning segment A of the shoreline jurisdiction, on the west bank of the South Fork Snoqualmie River.

Consultation with the Washington Office of Archeology and Historic Conservation indicates that a number of other archeological properties are recorded in the shoreline jurisdiction (WOAHP, 2002b). The specific locations of these sites are generally not disclosed to the public, but these are likely to be associated with past Native American use of the shorelines or post-Native American settlement of the valley.

3.7 Roads and Transportation Facilities

Transportation development in the upper Snoqualmie Basin is largely concentrated along Interstate 90 and state highways, and centered around communities like the City of North Bend. There are five large bridges crossing the South Fork Snoqualmie River in the City of North Bend. These include Bendigo Boulevard North (SR 202), West North Bend Way, Bendigo Boulevard South, the Snoqualmie Valley Trail along the former Burlington-Northern Railroad right-of-way, and the Snoqualmie Valley Railroad, just south of and parallel to West North Bend Way (Table 4).

Table 4. Major Transportation Features By Shoreline Segment

Shoreline Planning Segment	Predominant Roads/Bridges
A	Snoqualmie Valley Trail
B	Ballarat Ave. NE, NE 12th Street, Bendigo Boulevard North
C	West North Bend Way, Bendigo Boulevard S., Snoqualmie Valley Railroad
D	No river crossings; several small roads on east bank associated with residential development

Source: City of North Bend GIS, 2002.

3.8 Stormwater, Wastewater, and other Utilities

3.8.1 Wastewater Facilities

The City of North Bend sanitary sewer system currently serves approximately 39 percent of the City's population, including the urban growth area (Earth Tech, 2001). The sewer collection system is primarily located in the downtown, interchange (Exit 31) Si View and Forster Woods residential areas outside of the shoreline planning segments, but within the 100-year floodplain (Earth Tech, 2001). Originally constructed in 1950, more recent additions to the City's sanitary sewer system include service to the commercial area west of the South Fork Snoqualmie River. Flows in this area are collected and conveyed over the River via the South Fork Lift Station and an 8-inch force main in the Bendigo Boulevard right-of-way.

The City's wastewater treatment plant, located in shoreline segment C, provides secondary treatment and is located on a two-acre parcel on the east bank of the South Fork Snoqualmie River north of Bendigo Boulevard. After treatment and disinfection, wastewater effluent is conveyed through a 21-inch outfall that extends 445 feet to an 8-foot diameter diffusion manhole located on the east side of the South Fork Snoqualmie River channel. In periods of low river flow, the diffusion manhole has at times been exposed (Earth Tech, 2001). Discharges of treated effluent to the South Fork Snoqualmie River are permitted by the City's National Pollutant Discharge Elimination System (NPDES) Waste Discharge Permit, administered by Ecology. The NPDES permit establishes effluent standards and limitations for discharges during periods of low river flow (August, September, and October) and periods of high river flow (November through July).

3.8.2 Stormwater Facilities

Surface water runoff in the City of North Bend is collected and conveyed through streams and local drainage systems including open channels and roadside ditches, storm sewer pipelines, wetlands, infiltration systems, and retention/detention systems (RW Beck, 2001). Stormwater enters the South Fork Snoqualmie River in the City of North Bend from all of the tributary streams and several storm drain outfalls. There are three direct piped discharges to the South Fork Snoqualmie River in shoreline segment D, including a 96-inch arched culvert conveying an open swale and closed drains in the New Si View subdivision. Discharges to the River in shoreline segment C include open channels and a gated outfall through the Prairie Acres levee (RW Beck, 2001).

3.8.3 Water Supply

The Mount Si Springs, located northeast of the City near the west base of Mt. Si, serve as the City's current water source (RW Beck, 2001). Spring flow at Mount Si Springs occurs where an aquifer intersects with the ground surface and is captured by subsurface piping; excess discharge flows to the Middle Fork Snoqualmie River. The City is experiencing water rights issues and has initiated a moratorium on new water hook-ups until a solution can be implemented (RW Beck, 2001).

The Snohomish River Basin is a major source of municipal water supply for several communities including Everett, Seattle, southwest Snohomish County, and other areas (Snohomish River Basin Salmon Recovery Forum, 2001). Ecology has indicated that the Snoqualmie River Basin has been classified as critical, and is closed to new water rights. An inter-tie with a Seattle Public Utilities Cedar River water supply has been proposed to alleviate potential future water supply issues in North Bend as one alternative. A second alternative has been proposed to supply additional water to the City. The proposal calls for perfection of a water right for the well drilled by the City at Torguson Park in 1992 by pumping additional water to augment low flows in the Snoqualmie River system as a mitigation measure (HWA Geosciences, 2001).

3.8.4 Other Utilities

Electricity is provided to the City of North Bend by Puget Sound Power and Light Company and by Tanner Electric Cooperative. Power is transmitted from the Snoqualmie Switch substation to the North Bend distribution substation via a 115 kV line that crosses the South Fork Snoqualmie River in the Snoqualmie Valley Trail right-of-way (North Bend, 1995). Tanner Electric Cooperative recently installed a new electrical substation at the corner of Alm Way and NW 8th Avenue; this facility is located within the 100-year floodplain, but not mapped floodway (Ramsey, personal communication, 2002).

Puget Sound Energy (formerly Washington Natural Gas Company) provides natural gas to the City of North Bend through the Beaver Lake Gate Station. North Bend is served by one 4-inch diameter high pressure line approximately 12 miles long, one district regulator station (the Snoqualmie Town Border Station), and 25 miles of distribution main (North Bend, 1995). Puget Sound Energy recently completed installation of a new transmission line in the North Bend Boulevard North (SR 202) right-of-way. This transmission line crosses under the South Fork Snoqualmie River (Ramsey, personal communication 2002).

4.0 PHYSICAL CONDITIONS AND BIOLOGICAL RESOURCES

This report section documents geophysical and biological conditions along North Bend's shoreline jurisdiction including river channel and floodplain characteristics, water resources, wetlands and vegetation, wildlife habitat, and fish resources.

4.1 South Fork Snoqualmie Channel Migration Areas

4.1.1 Historic and Current Channel Migration

Portions of the South Fork Snoqualmie River have experienced historically active levels of channel migration; portions of the River, particularly in Segments A and B, remain active today due to the unconstrained river banks in these areas of the shoreline. In contrast, little channel migration currently occurs in shoreline segments C and D as channel migration has been limited by the construction of levees along portions of these segments in the 1960s. According to a King County study completed in 1996, channel migration zones in these areas are generally precluded where maintained flood control facilities withstand the erosional forces of 100-year floods without significant damage (King County, 1996).

Channel migration often occurs in areas of substantial gradient change, where high-gradient river systems transition to lower-gradient reaches. These transition areas are often the location of extensive gravel deposition, which in turn contributes to conditions conducive to lateral channel movement. Presently, much of the gravel carried by South Fork flows is deposited upstream of North Bend where the River has been narrowly confined between levees since the 1960s. North of the levees, in shoreline segments A and B, the River again deposits gravels and is characterized by numerous gravel bars and shifting channels. Downstream of this area, the gentler gradients only allow finer material to pass downstream.

The King County study *Channel Migration in the Three Forks Area of the Snoqualmie River* (Perkins, 1996) used aerial photographs and maps to determine historic rates and limits of channel migration, estimate probable future limits of migration, and develop maps showing channel migration hazard zones along the various portions of the Snoqualmie River, including the South Fork. The study noted that the highest historical migration rates were associated with large floods, such as those floods that occurred in 1959. The study also found that migration rates declined after 1961, attributing this decline to several factors including levee and revetment construction, a reduction in large floods, gravel mining to construct the current levees in North Bend, and channel changes likely related to changing sediment load*s* due to levee construction (Perkins, 1996). **Figure 8** depicts historic channel locations in the City's shoreline jurisdiction and adjacent areas dating to the mid-1800s. It should be noted that the primary study area for the South Fork extended from West North Bend Way northward; information provided by the study was limited for areas of the South Fork Snoqualmie River south of this road. Channel migration and avulsion hazard areas for the Middle Fork as they relate to the City of North Bend are also depicted on **Figure 8**.

4.1.2 Channel Migration Hazards

Channel migration hazards currently affecting the City's shoreline jurisdiction are differentiated into three zones corresponding to the risks associated with channel migration (severe, moderate, and avulsion). The avulsion hazard zone maps areas at risk of sudden changes to a new location, while the severe and moderate categories address areas prone to hazards from channel migration. These zones include the following areas:

Severe hazard areas: King County has mapped one severe hazard zone north (downstream) of the Snoqualmie Valley bridge in the northern portion of the City's shoreline jurisdiction. In several places, this zone extends beyond the mapped floodway of the River. This severe hazard zone generally covers areas occupied by the South Fork Snoqualmie channel between 1942 and 1993 (**Figure 8**).

Moderate hazard zone: King County has mapped a moderate hazard zone, also north (downstream) of the Snoqualmie Valley Trail bridge. This zone includes all South Fork Snoqualmie River channels known from historic sources dating back to 1865, as well as most river channel scars of unknown age (**Figure 8**) (URS Greiner Woodward Clyde, 2000).

Avulsion hazard zone: In the City limits, Silver Creek and its associated tributaries are mapped as an avulsion area, or an area of potential sudden channel change. King County (1996) identified this area as having the potential for sudden channel change associated with the potential for the Middle Fork to leave its current channel and flow into the South Fork (**Figure 8**). Current King County development regulations designate this area as a Moderate River Channel Migration Hazard.

4.2 Frequently Flooded Areas

According to mapping developed by the Federal Emergency Management Agency (FEMA) in 1989, a large portion of the City falls in the 100-year floodplain of the South Fork Snoqualmie River and the Middle Fork Snoqualmie River. This 100-year floodplain areas includes much of the downtown area of North Bend as well as several of its established residential areas. A smaller portion of this area is designated by FEMA as floodway (**Figure 3**). FEMA released their updated Flood Insurance Study (FIS) and draft working Flood Insurance Rate Map (FIRM) of the South Fork and Middle Fork Snoqualmie River in 1998. Since that time the study and map have been appealed by the City of North Bend and King County twice, resulting in the release of a new Draft Working Flood Insurance Rate Map in September 2001. FEMA technical review and adoption of the current Draft Working FIRM are pending.

When they occur, floods are most frequent in North Bend from November through February. Several flood events have been documented in North Bend during the 1900s; the largest flood recorded on the South Fork occurred in 1959 (URS Greiner Woodward Clyde, 2000). In November 1990, the year of the largest recorded flood on the mainstem of the Snoqualmie River, flooding caused considerable damage to urban areas of North Bend. An overtopped left bank levee on the South Fork contributed to flooding of the Ribary Creek area, while an overflow of the Middle Fork contributed to flooding along the Silver Creek corridor (URS Greiner Woodward Clyde, 2000). Gardiner Creek also experienced flooding.

Flood elevations on the South Fork are affected by Middle Fork overflows. During the November 1990 flood (with a recorded Middle Fork overflow of 30,100 cubic feet per second (cfs)), the left bank of the Middle Fork was overtopped just upstream of the Mount Si bridge. Overtopping also occurred downstream of the bridge near Southeast 108th Street. Overflow at the Mount Si bridge flowed through the northern section of North Bend along Silver Creek, entering the South Fork west of Ballarat Avenue (URS Greiner Woodward Clyde, 2000). Several homes were reported to be flooded during this 1990 event (URS Greiner Woodward Clyde, 2000). Based on FEMA analysis, much of this area would be under approximately five feet of water in a 100-year flood (Meadowbrook Farm Conservation Association et al., 1999).

Runoff from Gardiner Creek during the November 1990 event flooded fields located west of the Nintendo site and south of Northwest 8th Street (URS Greiner Woodward Clyde, 2000). The street crossing was also inundated during this event. Gardiner Creek floodwaters merged with Ribary Creek overflows at Alm Way, creating a ponded area on the western portion of the Tollgate property (URS Greiner Woodward Clyde, 2000).

4.3 Aquifer Recharge Areas

In 1998, King County adopted the *East King County Groundwater Management Plan* characterizing groundwater resources and aquifer recharge areas in the North Bend area. Aquifer recharge areas within the City are also characterized in the *2001 Hydrogeologic Evaluation Supporting the City of North Bend Water Right* (HWA GeoSciences, 2001) and have been mapped for the City.

All of North Bend's shoreline jurisdiction is considered a high aquifer recharge area sensitive to contamination. North Bend contributes as much as 60 inches of recharge annually to underlying aquifer systems. Groundwater in the shallow valley aquifer beneath North Bend occurs at depths ranging from 10 to 40 feet, primarily at a depth of 20 feet (HWA GeoSciences, 2001). The productive zone of this aquifer extends to a depth of approximately 250 to 300 feet. Most groundwater from this aquifer discharges to the Snoqualmie River at an estimated annual rate of 50 to 70 cubic feet per second (HWA GeoSciences, 2001). A portion of the groundwater discharges vertically downward into the deep aquifer system, and a minor percentage is withdrawn by water supply wells (HWA GeoSciences, 2001). The deep aquifer system reaches a depth of 550 feet north of North Bend in Snoqualmie, and 700 feet east of North Bend, approximately a mile and a half northeast of the North Bend airstrip.

4.4 Wetlands

The City contains several types of wetlands including forested wetlands, scrub-shrub wetlands, lacustrine wetlands, emergent wetlands, and riverine wetlands (**Figure 3)**. Information on wetlands in North Bend's shoreline jurisdiction was compiled from a review of several planning and development review documents. In 1991, Sheldon & Associates identified and mapped wetlands in the City using aerial photographs and soil type maps. In 1999, the Cities of North Bend and Snoqualmie adopted the Master Site Plan for their jointly owned 460-acre Meadowbrook Farm property. This Master Plan identified soil types, wetlands, riparian corridors, vegetation, and wildlife habitats on the site. Also in 1999, Sheldon & Associates prepared an assessment of the natural and beneficial functions of the floodplain on the City of

North Bend's portion of the Meadowbrook Farm, documenting wetlands on approximately one half of the site. Finally, the City has compiled sensitive area studies documenting stream and wetland habitat resources from a variety of private developments including the inventoried wetlands on the 229-acre Tollgate Farm site from the Tollgate EIS (2000), the Wyrsch I-90 property (2001), the Forester Woods Multi-Family Site (1997), and the Snoqualmie Plat/10th Street wetland complex (1996). The Tollgate EIS did not inventory wetlands located in the floodway.

Digital information on wetlands was also obtained in GIS format from the City. The GIS information is based largely on the wetland study prepared for the City (Sheldon and Associates, 1991), and on King County Sensitive Areas Ordinance information. These sources document known wetlands throughout the City, including wetlands in the floodway and shoreline jurisdiction.

Overall, there are approximately 122 acres of wetland in North Bend's shoreline jurisdiction. Most of these wetlands are located west of the South Fork Snoqualmie River, between Ribary and Gardiner Creeks (**Figure 3**). For the purposes of this inventory, wetlands are assumed to be associated with shorelines if they fall within 200 feet as measured from the top of bank, or if they are connected to the shoreline by a surface water connection. Under the Shoreline Management Act, the City's shoreline jurisdiction includes all areas 200 feet landward of the ordinary high water mark of the mainstem River, areas 200 feet landward of floodways, and associated wetlands.

There are several wetlands in the northern part of the shoreline planning areas including forested riparian wetlands associated with Gardiner and Ribary Creeks, and forested, scrub-shrub, and emergent wetlands on the Meadowbrook Farm site. There is also a significant forested wetland in shoreline segment C; substantial portions of the floodplain near this segment are also mapped as wetland. Several small wetlands are located in the floodplain near Segment B, while few wetlands in or around shoreline segment D. Additional information on individual shoreline planning segments is provided in Section 6.0 of this report.

Several of North Bend's wetlands are ecologically associated with the South Fork. Riverine impounding wetlands are floodplain wetlands associated with flood channels of the South Fork Snoqualmie River. These wetlands contain slow moving backwater in areas of vegetated remnant channels. Some of these channels actively flow during high runoff and flood events, but because they are impounded they do not convey active stream flows (URS Greiner Woodward Clyde, 2000).These wetlands have channels with dense, overhanging vegetation and are surrounded by high-quality, second-growth, mixed coniferous-deciduous forest buffers. Dominant plant species include Pacific willow, Sitka willow, red alder, salmonberry, red-osier dogwood, and lady fern (URS Greiner Woodward Clyde, 2000).

Riverine flow-through wetlands are linear wetlands with a unidirectional flow, typically occurring in active stream channels. These include wetlands associated with Gardiner Creek and Ribary Creek. Both are perennial streams with permanently saturated or inundated associated wetlands (URS Greiner Woodward Clyde, 2000). The vegetation in the scrub-shrub portion of the wetlands associated with Ribary Creek is a patchy mix of red-osier dogwood, willow, and Himalayan blackberry, with occasional red alder and black cottonwood (URS Greiner

Woodward Clyde, 2000). The wetlands associated with Gardiner Creek have a denser shrub cover dominated by red-osier dogwood, salmonberry, and western crabapple.

The City regulates wetlands and their buffers under its critical area regulations. According to the City of North Bend Sensitive Areas Ordinance, Category I wetlands presently require a 200-foot buffer, Category II wetlands a 100-foot buffer, Category III wetlands a 75-foot buffer, and Category IV wetlands a 35- to 50-foot buffer (Chapter 14.10, North Bend Municipal Code).

Table 5 identifies the number of wetlands located in the shoreline environment for each shoreline segment. These wetlands are discussed further in the segment discussions, in Section 6.0.

Table 5. Wetlands in North Bend Shoreline Jurisdiction

Shoreline Segment	Wetland Types	Approximate Total acreage
A	Emergent, scrub-shrub, forested, riverine	10
B	Forested, emergent, riverine	85
C	Forested, emergent, riverine	27
D	None	0

*: Numbers refer to the North Bend Wetland Inventory (Sheldon and Associates, 1991).

4.5 Habitat Types

The following habitat analysis is based on a review of reports prepared by Sheldon and Associates (1998), Raedeke and Associates (1996), and URS Greiner (1998) on the Tollgate Site (URS Greiner Woodward Clyde, 2000), and by Sheldon and Associates on the Meadowbrook Farm site (1999). This analysis also included review of aerial photographs provided by the City, and a field verification reconnaissance conducted for this report in March 2002.

At a larger landscape level, the habitats on the Tollgate site, including the wetlands, are part of a larger area of open space that includes the Meadowbrook farm to the north, the forested corridor of the South Fork Snoqualmie to the north, and forested portions of Rattlesnake Ridge to the west. The City of North Bend is located between or near large blocks of undeveloped land including Mount Si Natural Resource Conservation Area (8,041 acres), Weyerhaeuser's Snoqualmie Tree Farm (180,000 acres), the Cedar River Watershed (approximately 90,000 acres), and the Mount Baker-Snoqualmie National Forest (1.7 million acres) (King County, 1998). The 418-acre Three Forks Natural Area is located in King County at the confluence of the three forks of the Snoqualmie River, the largest river system in King County. Three Forks Natural Area includes over five miles of shoreline and is dominated by riverine, riparian, and wetland habitats (King County, 1998) (**Figure 1**). All of these areas form a sanctuary and migration corridors for a broad range of wildlife including black bear, elk, cougar, eagle, deer, and river otter (King County, 1998). Linear wetlands along North Bend's shorelines provide migration corridors and refuge areas for wildlife and regional connections to these areas.

While the City has protected several areas of open space, habitat connectivity is diminished by the number of roads crossing the study area. As a result of these habitat breaks, forested areas

have value for songbirds, small mammals and amphibians, but are limited in value for species with large home ranges such as elk and bear due to roads (particularly I-90), that pose barriers to travel (URS Greiner Woodward Clyde, 2000). The wildlife tunnel that passes under I-90 to the west of the junction with West North Bend Way does allow movement of wildlife such as deer and raccoons.

Several distinct habitat classes were identified in the City's shoreline jurisdiction. The characteristics and general locations of each habitat type are summarized in this section.

4.5.1 Upland Forest

4.5.1.1 Mixed Forest Upland With Dense Overstory

Large mature stands of mixed deciduous/coniferous trees are present along the shoreline of the South Form on Meadowbrook Farm. These stands are located in remnant floodplain areas adjacent to the active channel of the South Fork Snoqualmie River. This plant community is dominated by primarily native species, including red alder and western redcedar. Other species include big-leaf maple, black cottonwood, Sitka spruce, western hemlock, and Douglas fir. Understory vegetation includes red elderberry, Indian plum, common snowberry, salmonberry, swordfern, and bracken fern. Non-native shrubs include Himalayan blackberry and evergreen blackberry. The understory is well established with sapling and young western redcedar and Sitka spruce (Sheldon & Associates, 1999).

This plant community provides feeding, nesting, and cover habitats for a variety of species. Observed avian species included American robin, yellow warbler, tree swallow, rufous-sided towhee, red-breasted nuthatch, white crowned sparrow, dark-eyed junco, willow flycatcher, varied thrush, Northern flicker, hairy woodpecker, pileated woodpecker, common crow, western screech owl, golden-crowned kinglet, bushtit, and black-capped chickadee. Observed mammals included deer mouse, raccoon, coyote, and black-tailed deer. Elk reportedly use a number of trails through the forest along the shoreline.

4.5.1.2 Mature Conifer Forested Upland, Sitka Spruce

Two small stands of mature Sitka spruce have been identified on the Meadowbrook Farm and City limits (Sheldon & Associates, 1999). One stand is located the west edge of the Snoqualmie Valley trail, while a second substantially smaller stand is located along the west side of Boalch Avenue. This plant community could provide feeding, nesting, and cover habitat for a variety of wildlife species. However, due to the small size of these two stands, wildlife likely depends more on adjacent habitats, limiting the value of this community to the diversity it adds to adjacent plant communities. Observed bird species include American robin, red-breasted nuthatch, dark-eyed junco, Northern flicker, hairy woodpecker, golden-crowned kinglet, bushtit, and black-capped chickadee (Sheldon & Associates, 1999). Observed mammals included coyote and black-tailed deer.

4.5.1.3 Lowland, Second-growth Deciduous Forest

Lowland, second-growth deciduous forest along North Bend's shoreline is dominated by black cottonwood, red alder, and big-leaf maple. Mixed coniferous-deciduous forests also include western redcedar, western hemlock, Sitka spruce, and Douglas fir (URS Greiner/Woodward Clyde, 2000). The deciduous forest canopy is relatively open, allowing for a dense understory of salmonberry, vine maple, common snowberry, and red elderberry.

4.5.1.4 Young Deciduous Forested Upland, Limited Understory

This plant community is present on the Meadowbrook farm site along the east length of the Snoqualmie Valley Trail, in an area that once was cleared and now is vegetated with a dense stand of red alder trees. Additional species include young big leaf maple, Himalayan and evergreen blackberry (both invasive species), red elderberry, Indian plum, sword fern, and bracken fern.

This plant community provides habitat for a variety of species. Observed bird species include American robin, varied thrush, house sparrow, black capped chickadee, starling, purple finch, Northern flicker, and song sparrow. These birds seek cover in this habitat type and in adjacent forested areas. Observed mammals included vagrant shrew, deer mouse, eastern cottontail, raccoon, coyote, and black-tailed deer.

4.5.2 Riparian Forest

Vegetation along the South Fork Snoqualmie, Ribary, and Gardiner Creeks provides riparian habitat for many species. Riparian habitat along the South Fork between NW 8th Street and the Snoqualmie Valley Trail is comprised mainly of deciduous forest including black cottonwood, willow, and dense Himalayan blackberry (an invasive species).

4.5.2.1 Mixed Riparian Forest

This habitat type includes the mainstem of the South Fork Snoqualmie River as well as active side channels. Understory vegetation includes skunk cabbage, slough sedge, and reed canarygrass, while the forest canopy is composed of a mixture of deciduous and coniferous trees. Observed tree species rooted along the upslope of the ordinary high water mark include red alder, black cottonwood, big leaf maple, western redcedar, western hemlock, Sitka spruce, and Douglas fir.

The plant community along these channels provides feeding, nesting, and cover habitats for a variety of wildlife species. Observed bird species include American robin, yellow warbler, tree swallow, violet-green swallow, western screech owl, rufous-sided towhee, white crowned sparrow, dark-eyed junco, varied thrush, northern flicker, hairy woodpecker, common crow, pileated woodpecker, common crow, bushtit, and black-capped chickadee. Observed mammals include deer mouse, beaver, raccoon, coyote, and black-tailed deer. Pacific tree frogs have also been documented using this habitat. Common merganser were noted in the main channel of the Snoqualmie River, and elk are reported to used trails along the shoreline.

4.5.2.2 Mixed Forested Wetland/Riparian Forest

Mixed forested/wetland and riparian forests along North Bend's shorelines were reported in 1998 to be densely vegetated and inundated with standing water well into the growing season. The forested overstory consists of mature black cottonwood, red alder, and Oregon ash with numerous standing and fallen snags present. Shrub cover includes sapling deciduous trees, sapling western redcedar, Sitka willow, Pacific willow, Douglas spiraea, and nootka rose.

As part of prior land use activities, Gardiner Creek has been excavated and channelized across the Meadowbrook Farm site to its confluence with the South Fork Snoqualmie River. Vegetation includes yellow flag iris rooted in the channel, and skunk cabbage and big leaf avens along the channel edge. Himalayan blackberry and evergreen blackberry (both non-native, invasive species) dominate the disturbed areas and side-cast piles along the channel. Red alder trees, between 10 and 20 years old, dominate the overstory. Additional species include black cottonwood, salmonberry, Indian plum, sapling cottonwood, salmonberry, Indian plum, sapling big leaf maple, sapling Douglas fir, Sitka willow, and Douglas spiraea.

The riparian corridor along Gardiner Creek provides feeding, nesting, and cover habitats for a variety of wildlife species. Observed bird species included American robin, yellow warbler, tree swallow, violet-green swallow, rufous-sided towhee, white crowned sparrow, dark-eyed junco, varied thrush, northern flicker, hairy woodpecker, common crow, pileated woodpecker, common crow, bushtit, and black-capped chickadee. Observed mammals included deer mouse, Townsend's vole, Townsend's mole, beaver, raccoon, coyote, and black-tailed deer. Pacific tree frogs were also noted to use this habitat. The active stream channel also provides habitat for resident cutthroat trout and rainbow trout (WDFW, 2002). The channel provides wildlife a migration corridor connecting Rattlesnake Mountain and the South Fork Snoqualmie.

This plant community provides feeding, nesting, and cover habitats for a wide variety of wildlife species. Observed bird species included brown-headed cowbird, white crowned sparrow, American robin, yellow warbler, dark-eyed junco, willow flycatcher, varied thrush, Northern flicker, hairy woodpecker, pileated woodpecker, common crow, western screech owl, golden-crowned kinglet, bushtit, black-capped chickadee, black-headed grosbeak, and song sparrow. Observed mammals included deer mouse, raccoon, coyote, and black-tailed deer. Pacific tree frogs and Northwestern salamander were also noted to use this habitat.

4.5.3 Upland shrub

Typically, upland shrub areas are cleared upland areas or areas along roads. Plants typically include Himalayan blackberry and evergreen blackberry. Thick hedges of Himalayan blackberry and some salmonberry occur along the edges of pastures and roads in along the shoreline (URS Greiner Woodward Clyde, 2000). Additional species present in this habitat type include Scot's broom, sapling big leaf maple, sapling red alder, sapling black cottonwood, wild rose, and reed canarygrass. The Snoqualmie Valley Trail in the shoreline jurisdiction is bordered by deciduous forest and pasture.

Observed bird species using this habitat type include barn swallow, tree swallow, violet green swallow, American robin, starling, varied thrush, purple finch, yellow warbler, brown-headed

cowbird, house sparrow, black-capped chickadee, common crow, and song sparrow. These birds likely seek cover in this habitat and adjacent forested areas. Observed mammals included vagrant shrew, deer mouse, eastern cottontail, Townsend's mole, and coyote.

4.5.4 Shrub wetland

Shrub wetlands are generally located in small patches along the shoreline—larger areas of scrub-shrub wetlands are located to the west, outside of the City's shoreline jurisdiction. Vegetation consists mainly of Pacific willow and Sitka willow, as well as Douglas spiraea, and red-osier dogwood. Bird species include barn swallow, starling, common snipe, marsh wren, purple finch, brown-headed cowbird, white crowned sparrow, common mallard, American robin, yellow warbler, rufous-sided towhee, dark-eyed junco, willow flycatcher, varied thrush, Northern flicker, golden-crowned kinglet, bushtit, black-capped chickadee, black-headed grosbeak, and song sparrow. Many of these birds use these areas for nesting and cover habitats. Pacific tree frogs, red legged frogs, and Northwestern salamander were also noted to use this habitat.

4.5.5 Emergent wetland

Emergent wetlands are located in small areas in the City's shoreline jurisdiction. Vegetation primarily includes small-fruit bulrush, softrush, slough sedge, and other typical wet grass species, such as reed canarygrass, water foxtail, meadow foxtail, velvet grass, redtop bentgrass. In areas where deeper water is present, small communities of common cattail occur.

Bird species observed in this habitat include barn swallow, starling, common snipe, marsh wren, purple finch, brown-headed cowbird, red winged blackbird, common mallard, American robin, yellow warbler, tree swallow, violet-green swallow, Canada goose, American widgeon, and song sparrow. Many of these birds use the adjacent shrub and forested areas for nesting and cover habitats, while common mallard, marsh wren, and red winged blackbird nest in cattails. Observed mammals included deer mouse, Townsend's vole, Townsend's mole, vagrant shrew, long-tailed weasel, coyote, and black-tailed deer. Pacific tree frogs were also noted to use this habitat.

4.5.6 Pasture

Agricultural use in pasture areas of the shoreline includes production of "green chop" for dairy livestock. Approximately 83 acres of pasture exists on the Tollgate site and is actively grazed by cattle (URS Greiner, 1998). This area is predominantly vegetated with perennial rye, white clover, thistle, creeping buttercup, and common dandelion (URS Greiner, 1998). In addition, "green chop" for dairy livestock maintained off-site is grown on portions of the Meadowbrook Farm outside of the City of North Bend in the City of Snoqualmie shoreline jurisdiction.

Bird species found in this habitat type include barn swallow, tree swallow, violet green swallow, American robin, starling, common snipe, purple finch, yellow warbler, brown-headed cowbird, common mallard, Canada goose, American widgeon, common crow, glaucous-winged gull, and song sparrow. These birds likely seek nesting and cover habitat in nearby shrub and forested areas. Red-tailed hawks were observed hunting in the open grasslands. Observed mammals included vagrant shrew, deer mouse, Townsend's mole, Townsend's vole, longtailed weasel, coyote, and black-tailed deer.

4.6 Special Status Species

The Washington State Department of Wildlife (WDFW) maintains a Priority Habitats and Species (PHS) program to inventory potential state or federal proposed, threatened, or endangered species as well as other "priority" species of state concern. Digital PHS data were obtained and mapped as part of this shoreline characterization.

According to the PHS database, at least nine priority wildlife species are present in the City limits and adjacent areas (WDFW, 2002). These include wood ducks and hooded mergansers, pileated woodpeckers, great blue heron, band-tailed pigeons, ospreys, bald eagles, peregrine falcons, deer, and elk.

Correspondence received from the United States Fish and Wildlife Service (USFWS, 2002) indicates wintering bald eagles may occur in the shoreline jurisdiction during October 31 through March 31, and bull trout may occur in the South Fork Snoqualmie River (discussed below). The USFWS lists the following species of concern as potentially occurring in the City limits: Beller's ground beetle, California wolverine, Pacific fisher, Cascades frog, Hatch's click beetle, long-eared myotis, long-legged myotis, northwestern pond turtle, olive-sided flycatcher, northern goshawk, peregrine falcon, Pacific lamprey, river lamprey, western toad, valley silverspot, and white-top aster.

Wood ducks and hooded mergansers have been reported along South Fork mainstem by residents of the Circle River Ranch. Wood ducks and hooded mergansers are both cavity nesters, using holes in dead trees near the banks of rivers and ponds for rearing their young. Pileated woodpeckers use snags for breeding and foraging, and prefer snags at least 25 inches in diameter. Although such snags are present in all the shoreline management segments, they are infrequent.

Although no heron rookeries have been identified in the City limits, pasture areas in shoreline planning segments A and B provide foraging habitat for great blue herons, which forage for small mammals in these areas. The value of these pastures to heron is further increased by their proximity to wetlands, riparian corridors, and backwater channels, where herons may forage for amphibians, fish, and snakes. The nearest heron rookery is located near the south end of Lake Sammamish (URS Greiner, 1998).

Band-tailed pigeons have been documented in City limits (URS Greiner, 1998), but there are no known mineral springs, which are considered priority habitats for this species. Ospreys have been reported along the South Fork Snoqualmie; however, there are no known nests in the City. WDFW data shows one nest site just north of the City in the vicinity of the Mount Si Golf Course, and a second on the hill east of the Snoqualmie Mill (WDFW, 2002). Ospreys forage for fish along lakes and rivers and nest in the tops of snags near their foraging areas.

Bald eagles similarly forage along lakes and rivers; however, the nearest known nest tree approximately 12 miles away near the south end of Lake Sammamish (WDFW, 2002). Flooding of the river in the past has attracted large waterfowl concentrations, which may attract eagles in search of prey. Peregrine falcons have been observed in the Three Forks Natural Area and a

known nest site is located on the face of Mount Si. Peregrine falcons may forage in riparian corridors throughout the City's shoreline jurisdiction.

Dear and elk use travel corridors and migration routes in particular throughout shoreline planning segments A and B. The big brown bat and several species of *Myotis* bats all potentially may occur in the various shoreline management segments, although breeding habitat for many of these species is primarily limited to older forests. Bridges, buildings, and snags may all be used as roosting habitat.

4.6.1 **Bull Trout**

The WDFW rates the Snohomish Basin native char population (which include both bull trout and Dolly Varden, a closely related species that is difficult to distinguish) in the Snohomish Basin as healthy, based on populations monitored in the Skykomish Basin. Bull trout prefer clean, cold water with abundant, clean spawning gravel and good rearing habitat cover (clean cobbles and boulders, abundant large woody debris). Some bull trout are anadromous (i.e., hatch in freshwater, mature in saltwater, and return to freshwater to spawn, while others are freshwater resident fish, spending their entire lives in rivers, streams or lakes). Therefore, unlike chinook salmon, populations of bull trout have the potential to be present above Snoqualmie Falls.

For purposes of implementing the federal ESA, the USFWS classifies the entire Snohomish Basin (WRIA 7) as presumed habitat for bull trout. However, an extensive two-year survey of the Snoqualmie River basin above the falls by King County has not found any bull trout in this drainage basin (Berge and Mavros, 2001). Several locations along the South Fork upstream of North Bend were sampled using snorkel surveys as part of this 2000 study. In addition, no bull trout were found by the U.S. Army Corps of Engineers in surveys in the early to mid-1990s (Berge and Mavros, 2001; RW Beck, 2001). King County is continuing to conduct surveys to determine the presence of bull trout in areas upstream of the falls.

5.0 BEST AVAILABLE SCIENCE AND SHORELINE MANAGEMENT

The NMFS (1996) has identified six significant environmental "pathways," or factors that are important for the survival of salmonids. While this approach was prepared by NMFS for anadromous salmonids, its concepts when applied to North Bend's shorelines do provide a general assessment of ecological function of the river and its associated riparian areas and wetlands. These pathways include water quality, habitat access, habitat elements, channel conditions, flow/hydrology, and watershed conditions. These pathways are further broken down into "indicators." Indicators are generally of two types; (1) standards of measurement that have associated numeric values (e.g., six pools per mile); and (2) descriptive indicators (e.g., adequate habitat). The purpose of having both types of indicators is that numeric data are not always readily available; in those cases, a description of overall condition may be the only method available to evaluate salmonid habitat. For the purposes of this study, discussions of ecological functions are used to provide a general summary of the functions and values of various elements of North Bend's shoreline jurisdiction.

River ecosystems are formed and maintained by natural disturbances (such as landslides, debris torrents, and flooding) that contribute resources (such as woody debris, spawning gravel, and nutrients) to riparian and instream habitat. Therefore, processes that affect the habitat available to fish and wildlife in the North Bend shoreline jurisdiction operate at a watershed scale. Human activities have caused changes to these key processes as development has increased in the watershed and portions of the river have been channelized. Thus, the local habitat conditions that are the focus of this section of the study are a product of (and are continually being impacted by) natural processes and human-induced forces that are often beyond the influence of the City.

5.1 Best Available Science Overview

5.1.1 Channel Condition and Dynamics

NMFS (1996) and USFWS (1998) define properly functioning channel conditions and stream dynamics as a width/depth ratio of less than 10:1, naturally stable stream banks, and a prevalence of riparian and streamside wetlands hydrologically linked to the river system. Thresholds for "properly functioning" are a width/depth ratio of less than 12:1 and less than 80 percent disturbance of naturally stable banks.

As previously discussed, the channel migration zone refers to the area of likely lateral river channel movement over a given reach. Channel migration can be caused by natural or human-caused bank destabilization, rapid stream incision, stream bank erosion, and shifts in locations of river channels. River channels migrate horizontally as water currents erode banks, usually also depositing water-borne sediment on opposite banks. Channel migration zones tend to develop where riverbeds change abruptly from a steep gradient to a much gentler slope (King County, 1996). Formation is largely due to the decrease in the water's velocity, and because sediment settles out and forms easily erodable beds of alluvium in these areas of gradient change. In these

conditions, river channels may take meandering courses over the alluvium, migrating back and forth across valley floors and creating dynamic channel conditions.

Channel migration zones are usually determined by examining the lateral extent of river channel movement in the last 100 years. Also considered are the limits of the 100-year floodplain and areas of amplitude in river bends determined by drawing a line that connects the points of greatest variation measured from top of bank along a given stretch of river. This line includes any cut-off side channels or oxbows that have bed elevations at or below bankfull elevation.

Channelization projects have the potential to drain and dewater local aquifers/hyporheic zones adjacent to river systems. Channelization causes the greatest decline in groundwater levels nearest the stream and diminishing declines with increased distance from the stream. The result is the permanent removal of potential saturated storage volume essential for aquatic organism habitat, riparian vegetation, and subsequently bank stabilization, temperature regulation and nutrient exchange.

Ecological values of floodplain habitats along rivers where channel migration has been constrained by levees can sometimes be restored by constructing new levees more distant from the channel (so-called setback levees). Setback levees permit controlled inundation of adjacent floodplains and allow the river to meander within a belt-width prescribed by levee dimensions (Interfluve, 1999). Throughout the Pacific Northwest, it has been common practice in channelized river systems with extensive levees and revetments to maintain the channelization structures by keeping them clear of vegetation, especially woody riparian vegetation (Nolan, 1984). Vegetation removal can be either a direct management goal or an indirect consequence of other procedures such as channel straightening or bank protection works. The rationale for vegetation removal includes access to levees for inspection, flood fighting, rodent burrow reduction, prevention of root induced piping (the lateral movement of water through large soil macro pores), reduced soil loading due to vegetation, decreasing erosion due to soil exposure following tree windthrow, and decreasing frictional resistance to maintain flood conveyance (Shields and Gray, 1992; Nolan, 1984). Many government managers, landowners, and flood control districts have been reluctant to allow vegetation to grow along levees and revetments due to the perceived risk of failures induced by the presence of vegetation.

Among the simplest, most direct, and least expensive ways to improve the integrity of stream systems affected by channelization and confinement is to alter or halt the current management strategies that are a partial cause of continued habitat degradation. Management strategies that encourage and allow natural channel processes to evolve over time tend to succeed because of the positive feedbacks derived from working with the natural tendencies of a fluvial system rather than against them (Ebersole et al., 1997). There are, however, only a handful of large reach and valley segment scale case studies of channelized lowland river restoration. The Nature Conservancy has been working on setback levee construction and levee breaching on the Lower Cosumnes River in the Central Valley of California to restore the river's access to its historic floodplain along most of the lowland river corridor. Since 1995, this has entailed taking parcels of agricultural land along the river out of production and breaching the flood retention levees in numerous locations. Accompanying this reconnection has been an intensive reforestation effort on the historic floodplain. At all sites, the floodplain connectivity and flood frequency were increased by reducing the bank-full channel capacity, decreasing the channel slope, lowering the

bank level, and raising the bed level. Restoring the hydrologic connectivity with the former floodplain promoted the deposition of sediment on the floodplain and the retention of nutrients such as phosphorus and iron (Kronvang et al., 1998).

5.1.2 Water Quality

Water quality indicators for properly functioning conditions as described by the NMFS (1996) and USFWS (1998) include temperature, sediment/turbidity, and chemical contamination/nutrients. For salmonids, water temperatures in the range of 62 degrees Fahrenheit are at the upper limits of an "at risk condition" (NMFS, 1996). Temperatures below 57 degrees are required for "properly functioning" systems and temperatures in excess of 64 degrees are "not properly functioning." Water quality can be influenced by the amount of riparian cover, erosion from land clearing and timber harvesting, and runoff from developed areas.

Turbidity in streams is typically due to erosion of banks and sediment loading from other water bodies and stormwater runoff. The extent that turbidity affects salmonids depends on many factors including background stream turbidity levels, amount of increase in turbidity, and duration of increased turbidity (NMFS, 2000). Servizi and Martens (1992 *in* NMFS, 2000) found that turbidity does not cause direct salmonid mortality unless extremely high levels occur; however, other studies have shown that juvenile salmon avoid turbid water when turbidity exceeds certain threshold levels. Dissolved oxygen levels may temporarily be reduced with the increase in turbidity, and large concentrations of suspended solids may cause sediment deposition in spawning gravels.

5.1.3 Habitat Access and Elements

Habitat elements include substrate, large woody debris (LWD), pool frequency, pool quality, off channel habitat, and refugia (NMFS, 1996; USFWS, 1998). NMFS (1996) and USFWS (1998) define properly functioning conditions for these indicators, respectively, as:

- Gravel and cobble dominated substrate with less than 20 percent embeddedness;
- LWD (greater than 24 inches diameter and 50 feet long) at greater than 80 pieces per mile;
- Approximately 70 pools per mile; a prevalence of high quality pools over 3 feet deep;
- A prevalence of backwaters and off-channel areas; and
- A prevalence of high quality refugia including adequate buffers and riparian reserves.

Riparian areas are lands adjacent to streams and lakes where the interactions between the land and water create a diverse and productive habitat for plants and animals (Hall, 1998). The availability of water, moist rich soils and a variety of plants make the area attractive to wildlife, livestock and people. The size of the riparian area and the extent of interaction between the land and the water vary with the size of the stream (Bilby, 1988). In small, upland streams with typically small amounts of stream flow, the forest or other adjacent land use, dominates the

stream. Living trees provide shade that keeps water temperatures cool. Dead and fallen trees become large woody debris and provide habitat and cover for insects, amphibians and fish and create pools that help control sediment and nutrient transport. With little sunshine reaching the stream, the forest provides food in the form of insects, leaves, needles, twigs and branches for the insects, amphibians and fish that live in the stream (Gregory et al., 1987). In larger, wider streams and rivers, the forest and water interact frequently with each other (Bilby, 1988). High stream flows can undercut trees, change the flow path of the river, and deposit nutrient rich sediment onto the forest floor. The forest in turn provides shade and wood to the stream. In very large rivers, a large floodplain forest influences channel migration and development of forest islands within the channel migration zone. In these streams, there is usually an extensive area of active exchange of water and nutrients between surface and subsurface water through an area called the hyporheic zone.

Whatever the size of the stream, riparian areas help to maintain the ecological health of the stream. The water quantity and quality in streams reflect conditions in the watershed including the riparian areas and the upland areas (Naiman et al., 1992). Healthy streams and watersheds provide clean water, fish, wildlife habitat, and natural flood and sediment control. Trees and shrubs along the stream slow flood waters and provide time to infiltrate the ground, which can reduce flooding in downstream areas. Streamside vegetation can also filter out pollutants before they reach the stream, maintaining stream and groundwater quality. Sediments and nutrients that get filtered out in the riparian zone are quickly colonized by new vegetation, which stabilize the sediment and use the nutrients for growth.

Riparian areas affect the delivery and routing of sediment into and through streams. Management of upland areas can alter the processes that deliver water, wood and sediment to riparian areas, suggesting the importance of taking a watershed view of riparian areas. Changes in the amount and timing of water delivery to streams (at unusual times or in unusually high or low amounts), can affect the reproduction or growth of various plants and animals. Slope failures provide wood and sediment to streams that help create diverse habitat, but an increase in slope failures can overload channels with sediment or cause excess scour, both of which create less diverse habitat.

Riparian vegetation on in floodplains and along streambanks also provides a buffer to help mitigate the impacts of urbanization (Finkenbine et al., 2000). Such vegetation provides significant strength to streambanks, provides temperature-regulating shade to the stream surface, and acts as a source of large woody debris. Riparian vegetation may be removed by bank erosion and by as a means to increase flood conveyance. On many urbanized streams, accelerated bank erosion and restricted channel corridor width leave little room for riparian vegetation.

A more traditional method favored by most engineers for accommodating riparian vegetation on flood control structures is to overbuild or enlarge the levee or revetment, which provides a zone for roots and vegetation on the landward side of the structure while also ensuring the integrity and margin of safety of the structure. However, due to the reduced flood regime, altered substrate conditions and reduced moisture availability, these levee sites are usually suitable only for upland species rather than typical streamside, riparian communities that prefer moist to wet conditions. While this does not provide all the attributes of a properly functioning riparian zone, it does provide surrogate vegetation habitat and ecosystem function of greater value than unvegetated structures. In the Pacific Northwest, the establishment of conifers in this overbuilt

zone of levees could easily be accommodated in most situations and allow for the long-term recruitment of large woody debris to promote habitat complexity in simplified river systems.

5.1.4 Watershed Conditions, Flow/Hydrology

NMFS (1996) and USFWS (1998) the function of watershed conditions using a number of factors. In general, watershed conditions are defined as "not properly functioning" by the presence of valley bottom roads, the disturbance of greater than 15 percent of a watershed, and fragmented riparian conditions. Beyond this threshold, watershed conditions can be expected to continue to degrade. NMFS (1996) and USFWS (1998) also consider flow/hydrology to be not properly functioning when there are pronounced changes in peak flows and base flows, and when there has been a significant increase in impervious surface coverage in a basin, most often attributed to roads.

One of the most important factors in streams and rivers in urban or urbanizing areas is an altered hydrologic regime. As a watershed is developed, impervious surfaces such as roofs and pavement quickly shed runoff, resulting in overland flow of runoff that was formerly conveyed primarily by subsurface flow (Booth and Jackson, 1997). The transport of runoff to streams by gutters, drains, and storm sewers adds to the "efficiency" of developed areas' ability to quickly shed runoff. The development of a significant level of impervious surfaces and drainage networks within a watershed can increase peak flow magnitude, alter watershed response time, or "flashiness," and lower summer base flows (Henshaw and Booth, 2000; Finkenbine et al., 2000).

Finkenbine et al. (2000) found that increased imperviousness results in larger and more frequent floods, greater total surface runoff, and decreased time to produce runoff. Quantifying the level of development within a watershed that is likely to result in channel degradation has been examined by a number of authors (Booth and Jackson, 1997; Henshaw and Booth, 2000; Schueler, 1995). The methods for quantifying urbanization, and the levels of urbanization likely to adversely impact channel stability and aquatic habitat, continue to be explored and need refinement before they can be applied as predictive tools. In western Washington, Booth and Jackson (1997) found Increased channel instability and decreased quality of fish habitat in watersheds with greater than 10 percent effective impervious area (EIA). Significantly changed hydrology is probably the principle driver of urban channel degradation (Finkenbine et al. 2000).

5.2 South Fork Snoqualmie Properly Functioning Conditions

Although the area of the Snoqualmie River lies above a natural fish barrier (the Snoqualmie Falls), it still contributes significantly to the overall productivity of listed salmonid species occurring downstream. For example, it provides continuous sources of cold surface and groundwater, filters pollutants via associated wetlands and vegetation, and contributes large woody debris, gravel, nutrients and food sources for salmon downstream (Snohomish Basin Salmon Recovery Forum, 2001). In 1995, the Snohomish River Basin Work Group published fish distribution maps for wild chinook, coho, chum, and pink salmon, and steelhead trout throughout the Snohomish Basin. The maps used existing data and the collective knowledge of those most familiar with the species and their habitat to show the distribution of primary spawning areas, summer and winter rearing for juveniles, and adult holding pools. However, data

on juvenile salmonid use of the Snoqualmie River system is particularly deficient. To fill this data gap, King County is currently planning to conduct fish presence surveys for the mainstem Snoqualmie in the near future (Snoqualmie Watershed Forum Strategy and Work Plan, 2001).

According to WDFW's Streamnet data (2002), the South Fork Snoqualmie contains cutthroat and rainbow trout, whitefish, and sculpin. Cutthroat trout are present in Ribary and Clough Creeks. No priority fish species are mapped in the South Fork Snoqualmie in City limits. However, as previously discussed, for purposes of implementing the federal ESA the USFWS classifies the entire Snohomish Basin (WRIA 7) as presumed habitat for bull trout.

5.2.1 Water Quality

In 1994 a total maximum daily load (TMDL) study was completed for the Snoqualmie River. This study identified several water quality issues including low dissolved oxygen, high temperature, excessive phosphorus, and bacterial contamination. Recommendations included limiting inputs from municipal wastewater systems, and controlling pollutants from agricultural and dairy operations (RW Beck, 2001).

Water quality in Gardner and Ribary Creeks has been found to be in good condition, largely due to the origination of these streams in undeveloped foothills (RW Beck, 2001).

5.2.2 Habitat Access and Elements

The South Fork of the Snoqualmie River lies above a natural fish barrier (the Snoqualmie Falls). For all the shoreline segments, no other barriers to adult and juvenile salmonid (salmon and trout) migration on the South Fork Snoqualmie River have been identified.

A lack of quantitative, site-specific data for North Bend's shoreline jurisdiction limits the evaluation of substrate, LWD, pool quality, and pool frequency. However, even without quantitative data, it is likely that due to construction of levees and other shoreline modifications, the shoreline areas of the South Fork Snoqualmie River do not meet the thresholds established for "properly functioning conditions" for these habitat elements. In Segments C and D, North Bend's shorelines are dominated by levees along both banks, which have straightened, confined, and simplified the river channel. Channelization and levees have eliminated connections with side- and off-channel aquatic habitats, decreased the contribution of prey organisms to the river by precluding functioning riparian vegetation habitats, and precluded the recruitment of small and large wood from areas most likely to contribute this material. Channelization and levees also reduce river processes that form pools, side channels and other habitat features used by fishes such as trout.

The headwaters of the South Fork Snoqualmie River are predominantly located in national forest and private commercial timberlands. As a result, urbanization and development have been limited in these areas compared to urban areas in the Puget Sound lowlands. However, the upper watershed has been affected by timber harvest and road building practices that have likely reduced the ability of some riparian areas to provide wood and shade to the rivers and stream channels, and continue to contribute fine sediments from road construction and landslides. In

addition, water velocity refugia in the South Fork have been reduced by alteration of the shoreline, reducing habitat quality and quantity by increasing water velocities.

5.2.3 Channel Condition and Dynamics

Levees exist along the South Fork banks throughout the City, beginning at the 1-90 bridge and extending downstream to the Snoqualmie Valley Trail Bridge. The right bank (or Reif Road Levee) was constructed with the lower top elevations typically 2 to 3 feet lower than the left bank (Si View Park Levee). The purpose of this was apparently to direct floodwaters in excess of the leveed channel capacity into the right overbank floodplain during a major flood, rather than into the left overbank floodplain where the North Bend business district is located. Since the levees were built in the early 1960s, the right bank floodplain has been partially urbanized (resulting in increases in flood levels where obstruction of overbank flow paths have occurred) (URS Greiner Woodward Clyde, 2000).

A lack of quantitative data limits the accuracy determinations for width/depth ratios and stream bank stability. However, based on habitat conditions observed in the field, it is evident that shorelines in North Bend do not meet the thresholds for "properly functioning" and appear to be at least "at risk" (i.e., width depth ratio less than 12:1 and less than 80 percent of naturally stable banks). Higher quality habitats are found in shoreline segments A and B, while, in general, the channel condition and dynamic nature of segments C and D are degraded; in these leveed areas, river width averages about 80 feet (RW Beck, 2001).

Floodplain connectivity is determined more qualitatively. Although wetlands do occur in the adjacent floodplain in several segments, they are disconnected from the river by the existing system of levees. In particular, Segments C and D appear to be "not properly functioning" due to the lack of surface water connection between the river and adjacent wetlands or mapped 100-year floodplain due to the presence of levees.

5.2.4 Flow/Hydrology and Watershed Conditions

The average annual flow for the South Fork of the Snoqualmie River measured in the city limits at the United States Geological Survey (USGS) stream gauging station located upstream of Bendigo Boulevard South is 539 cubic feet per second (cfs) (URS Greiner, 2000). Peak streamflows occur during winter floods and are typically caused by a combination of precipitation and snowmelt. These flooding events normally occur during November and February. The highest South Fork flow currently published by the USGS is 13,000 cfs during a November 1959 event. More recently, the flood of November 24, 1990 had a published main channel gauge flow of 10,900 cfs. This event caused significant flooding in North Bend west of the river channel (URS Greiner, 2000). South Fork streamflows during late summer often drop to less than 100 cfs.

According to the Pacific Northwest Salmon Habitat Indicators Pilot Project for the Snohomish Basin, road density near the City of North Bend ranges from 2.6 to greater than five kilometers of road per square kilometer of land in the Basin. Based on the modeled road density, total

impervious area is estimated between five and greater than 20 percent near the city of North Bend (Ecology, 1999).

While flooding is an issue in North Bend, peak and base flows on the mainstem of the South Fork are likely more closely related to the City's location on an alluvial plain and influenced by conditions in the upper watershed (timber harvesting, road building) than by land use activities in North Bend. When looking at the entire South Fork watershed, the City's contribution to total impervious area is low.

However, local flooding can occur where mainstem overflows enter local streams, such as Ribary and Gardiner Creeks, and where flows from the Middle Fork enter Silver Creek. The hydrology of these smaller and more localized stream systems is likely influenced by land use and development patterns in North Bend. Modeling by Northwest Hydraulic Consultants (2001) indicates that during a 100-year flood event, the South Fork Snoqualmie would overflow in northwest shoreline segment D and contribute approximately 3,000 cfs to Ribary Creek in southwest segment C. The only existing route for water to exit the South Fork Snoqualmie in this reach is over Bendigo Boulevard (the boundary between segments C and D), which would have an average overtopping depth of 2.9 feet according to the modeling (Northwest Hydraulic Consultants, 2001).

The modeled 100-year flow for Gardiner Creek is 338 cfs, with the area above I-90 contributing approximately 64 percent, or 218 cfs, to this flow. Ribary Creek would overtop its banks just upstream of Bendigo Boulevard in the modeled scenario. Approximately 1,460 cfs would subsequently overflow from Ribary Creek into Gardiner Creek. Flows for the 100-year event on Clough Creek, which enters the South Fork just south of the City limits, were modeled at 539 cfs.

6.0 CONDITIONS BY INVENTORY SEGMENTS

An overview of baseline inventory conditions for each of the four inventory segments is provided below. Each segment discussion identifies current land use, habitat, critical resources, and "opportunity areas." As part of the inventory process, this report identified several "opportunity" areas. Areas were selected for their potential to protect or contribute to the long-term improvement in shoreline conditions. This report incorporates recommendations from the *South Fork Tributaries Action Plan* study (2001), and the *Meadowbrook Farm Master Plan* (1999). Individual segment conditions are shown in **Figures 9 through 12** in Appendix A.

6.1 Segment A – Snoqualmie Valley Trail Bridge Downstream to City Limits (West Bank Only)

Summary: Extending north from the Snoqualmie Valley Trail crossing to the north City limits (RM 1.2 to RM 1.9), this segment includes the west side of the River only. This segment is unconstrained by dikes. Land use in Segment A is predominantly grazed pasture as well as parks and open space on Meadowbrook Farm and the Tollgate property. Gardiner Creek, and Ribary Creek enter the South Fork Snoqualmie River in this segment, and 10 acres of wetland have been identified in the shoreline jurisdiction.

Current Land Use

Existing land use in Segment A is predominantly forested open space parks, and agriculture. This segment is dominated by Meadowbrook Farm, an historic farm property open to the public, and the Tollgate property, a dedicated open space immediately south of Meadowbrook Farm in public ownership by King County. Meadowbrook Farm is predominantly undeveloped land crossed by several trails, with a parking area and interpretive center located west of Boalch Avenue. Approximately 204 acres of Meadowbrook Farm is located in the City limits, with 2,000 feet of shoreline frontage. Approximately 70 acres of the Tollgate property is located in Segment A, with 1,500 feet of shoreline frontage. The Snoqualmie Valley Trail allows public access through the Tollgate property and continues through Meadowbrook Farm to the north. North Bend's comprehensive plan and zoning map indicate future land use to remain predominantly unchanged, except for an employment park designation (EP-1) in the privately owned undeveloped portion of Segment A between the Meadowbrook and Tollgate property. Current impervious surface in this shoreline segment is low at approximately six percent; however, a slight increase in impervious surface will likely occur with future development in areas zoned for employment park.

Critical Resource Areas

This segment provides several important links to the Three Forks Natural Area, local wetlands, and to Rattlesnake Ridge. Dominant habitat features include the unconstrained River channel and the forested corridor located along the west bank.

Two streams, Gardiner Creek and Ribary Creek enter the South Fork Snoqualmie in this segment. Gardiner Creek drains a watershed of approximately 820 acres, and originates on Rattlesnake Mountain, south of North Bend. Major sources of runoff in the Gardiner Creek watershed include the Forster Woods development, I-90, and the Nintendo Property (URS Greiner, 2000). Stormwater runoff from Forster Woods and the Nintendo site passes through a detention pond prior to discharge to the stream (URS Greiner, 2000). Runoff from I-90 drains directly to Gardiner Creek without detention (URS Greiner, 2000). Ribary Creek is discussed further in Segment C.

Much of the forest in Segment A is complex in structure, with trees of varying ages including black cottonwood, red alder, spruce, and Douglas fir, along with snags and large woody debris (URS Greiner Woodward Clyde, 2000). A small stand of Sitka spruce is located adjacent to the Snoqualmie Valley Trail. Large woody debris carried by floodwaters is abundant along the shoreline (URS Greiner Woodward Clyde, 2000); woody debris provides habitat for small mammals, amphibians, and birds. Overall, the interspersion of forest, pasture, wetland, and three riverine systems creates diverse water, food, nesting, and cover habitat for wildlife.

Several wetlands were identified in Segment A, totaling approximately 10 acres. A large wetland mosaic is present on the Meadowbrook Farm site north of Gardiner Creek. In the City limits, this wetland mosaic is bounded by Gardiner Creek to the south, Boalch Avenue to the west, and the Snoqualmie Valley Trail to the east. A tributary to Gardiner Creek originates in this wetland and flows south to join Gardiner Creek. The wetland continues offsite, to the east of

the Snoqualmie Valley Trail, to potentially connect to the South Fork Snoqualmie River. The wetland includes an emergent (PEM), a scrub-shrub (PSS), and a forested (PFO) component.

Habitat Limiting Factors

While most of this reach retains a natural or semi-natural character, limiting factors in this segment include habitat disturbance by invasive species (which inhibit the growth of native flora, and reduce food and cover values), lack of forest structural diversity in areas of immature forest, and disturbance caused by park use and vegetation management. Riparian vegetation along the South Fork between NW 8th Street and the Snoqualmie Valley Trail is characterized by black cottonwood, willow, and Himalayan blackberry. A corridor of forested habitat varying in width from several feet to several hundred feet follows the South Fork from this segment north to its confluence with the Middle Fork. Riparian vegetation along the river is an approximately 25-to100-foot wide early successional/mixed age stand dominated by cottonwood.

The river in this segment has forested banks and flows through a broad alluvial floodplain. Multiple islands and mid-channel bars add to habitat complexity in the river channel. The South Fork Snoqualmie experiences active channel migration in this reach. Historical channels of the South Fork are shown on **Figure 8**. Large gravel bars are evident along the South Fork between Circle River Ranch and the Snoqualmie Valley Trail bridge (URS Greiner, 2000). In addition to gravel bar formation, aerial photographs of this section of the river show accumulations of logs and a braided river channel condition (URS Greiner, 2000). Sediment deposition in this section of the River is likely influenced by the presence of levees upstream of the Snoqualmie Valley Trail bridge. Downstream of the levees the South Fork deposits a significant portion of its sediment load as the floodplain rapidly widens, the river gradient flattens, and the floodplain velocities decrease (URS Greiner, 2000).

Opportunity Areas

Opportunity Area A-1 *(Conservation, Rehabilitation, Restoration)*

Area A-1, shown on **Figure 9** in Appendix A, is an area of second-growth mixed forest on the Meadowbrook Farm, between the west bank of the South Fork Snoqualmie River and the Snoqualmie Valley River Trail. Tree species include several large spruce, red alder, and black cottonwood, along with red-osier dogwood, western redcedar and hemlock in moister areas, and Douglas fir in uplands. No old-growth forest remains, although there are occasional significant specimen conifers (Meadowbrook Farm Conservation Association et al., 1999).

Much of Area A-1 has been preserved as open space, and portions of this area have been restored. The area is designated “forest preserve” and “reforestation area”(Meadowbrook Farm Conservation Association, et al., 1999*).*

Further actions to enhance the ecological function of Area A-1 could include continued maintenance to remove invasive species such as Himalyan blackberry. These actions could also include continued implementation of recommendations contained in the *Meadowbrook Farm Master Site Plan* (Meadowbrook Farm Conservation Association et al., 1999), replanting the existing mixed forest with western redcedar, hemlock and Sitka spruce.

Opportunity Area A-2 *(Rehabilitation, Restoration)*

Area A-2, shown on **Figure 9** in Appendix A, includes a portion of the Tollgate property and privately owned properties designated for Employment Park development. The privately owned properties in Area A-2 may offer the option to transfer development rights off of their properties if pending policy proposals to create a Transfer of Development Rights program for the Tollgate/Meadowbrook Neighborhood are adopted by the City of North Bend. The Tollgate Farm area has already been purchased as open space by King County in 2001. However, as with area A-1, this area offers opportunities for invasive species removal and maintenance, and for the replanting of the existing mixed forest with native trees and shrubs.

Opportunity Area A-3 *(Conservation, Rehabilitation)*

Area A-3, shown on **Figure 9** in Appendix A, includes Gardiner Creek, which flows along the south edge of Meadowbrook Farm. In this area, Gardiner Creek is currently a straight-line ditch with steeply cut banks, providing low hydrologic input and habitat benefits. Opportunities include removing invasive species and planting with native species to reduce sedimentation, slow overland flows during storm events, and improve wildlife habitat.

Backwater from the South Fork Snoqualmie River increases flooding potential in Gardiner Creek at the South Fork Snoqualmie Valley trail crossing and the Boalch Avenue crossing (South Fork Tributaries Action Plan, 2001). This area provides opportunities for stream restoration along the length of Gardiner Creek, as well as the potential to increase available off-channel habitat for fish for the South Fork where Gardiner Creek joins the South Fork Snoqualmie River.

Opportunity Area A-4 *(Conservation, Rehabilitation)*

Area A-4, shown on **Figure 9** in Appendix A, includes that section of the Meadowbrook site located between the Snoqualmie Valley Trail and Boalch Avenue. The section west of the Snoqualmie Valley Trail contains a forested wetland, an emergent/scrub-shrub/forested wetland, and an open water/scrub-shrub/forested wetland mosaic, which are likely hydrologically connected beneath the Snoqualmie Valley Trail to the South Fork Snoqualmie River. This area is already preserved as a public park and crossed by the Samuel Hancock Trail. However, this area presents opportunities for removal of dense Himalayan blackberry thickets.

6.2 Segment B – Snoqualmie Valley Trail Bridge Downstream to City Limits (East Bank Only)

Summary: Segment B extends from approximately RM 1.2 to RM 1.9. This segment is unconstrained by levees. Land use in Segment B is low-density residential, and a large forested tract on the Tollgate property has been preserved as open space. Silver Creek and an unnamed stream enter the South Fork Snoqualmie River in this segment, and the segment contains floodways conveying flood flows from the Middle Fork Snoqualmie River via Silver Creek and the unnamed stream. One large wetland and three small, linear wetlands, all associated with Silver creek and the unnamed drainage, have been identified in the shoreline jurisdiction.

Current Land Use

Land use in Segment B is predominantly forested open space and single-family residential neighborhoods. The comprehensive plan and zoning map indicate that future land use outside of designated open space areas is low-density residential. Current impervious surface is approximately 19 percent; a significant future increase in impervious surface is possible under current land use projections.

Critical Resource Areas

The reach of the South Fork Snoqualmie River adjacent to this segment is discussed in Segment A. Several floodways associated with Silver Creek and two unnamed tributaries enter the South Fork in this segment. This segment contains an approximately 85 acres forested, emergent, and riverine wetland. The remnant forest and wetland habitat provides forage, perch and limited nesting opportunities for wildlife. Silver Creek offers a limited wildlife corridor through the residential area.

Silver Creek lies in the floodplain area between the South Fork and the Middle Fork Snoqualmie River, north of the Snoqualmie Valley Trail. This stream flows northwest through the City to enter the South Fork Snoqualmie on the Tollgate Site. This ephemeral stream conveys local runoff as well as Middle Fork overflows and is designated as a floodway on the City's floodplain maps. Overflows occur into Silver Creek when Middle Fork flows approach a 10-year peak flood flow level (approximately 28,000 cfs). Development has occurred in several places in the floodway, and driveway and road culverts further constrict flow. An unnamed drainage way flows through the north section of the Tollgate site to the South Fork Snoqualmie.

Habitat Limiting Factors

Limiting factors in Segment B include a lack of diversity in species composition and forest structure in the floodways along Silver Creek and the unnamed tributary. Invasive species are common, particularly Himalayan blackberry and Scot's broom that limit the growth of riparian forest species. The reach of the South Fork Snoqualmie River adjacent to this segment is discussed in Segment A.

Opportunity Areas

Opportunity Area B-1 *(Conservation, Rehabilitation)*

Area B-1, shown on **Figure 10** in Appendix A, consists of the approximately 70 acres of open space on the Tollgate Site along the east bank of the South Fork Snoqualmie River. This is an area of second-growth mixed forest, consisting predominantly of coniferous species, including several large spruce, western hemlock, and Douglas fir. This forest also contains deciduous species such as cherry, several large red alder, large black cottonwood, and red-osier dogwood. B-1 includes the wetland corridors of Silver Creek and the unnamed tributary. This area is already preserved as open space. There are, however, additional opportunities for removal of invasive species.

Opportunity Area B-2 *(Rehabilitation, Restoration)*

Area B-2, shown on **Figure 10** in Appendix A, includes the non-wetland corridors of Silver Creek and the unnamed tributary. There are opportunities in this area to remove invasive species along these corridors and to plant native species to reduce sedimentation, slow overland flows during storm events, and improve wildlife habitat. The Silver Creek corridor is under investigation in the City of North Bend Flood Benefit Cost Study as a possible location for a flood conveyance channel to reduce the potential impact of river flooding from the Middle Fork

of the Snoqualmie River. Additionally, the Silver Creek corridor has been identified as a potential route to deliver water from the City well site in Torguson Park to the Snoqualmie River system as an in-stream flow enhancement mitigation measure to secure additional water rights for the City. In the event the City pursues either of these alternatives, it may be possible to enhance the Silver Creek Corridor to create a functional riparian corridor. Implementing any significant changes to the Silver Creek corridor would require extensive coordination with the multiple adjoining residential property owners.

6.3 Segment C – Snoqualmie Valley Trail Bridge Upstream to Bendigo Boulevard Bridge

Summary: Extending north from the Bendigo Boulevard bridge crossing, downstream to the Snoqualmie Valley Trail bridge (RM 1.9 to RM 2.8), this segment includes both sides of the river. Segment C is constrained by levees along both banks and includes the urban edge of downtown along the east bank, and a mix of rural and industrial areas to the west. Ribary Creek parallels the west bank through this segment.

Current Land Use

This segment is flanked by the downtown area and residential properties along the east bank, and commercial uses, including the Nintendo campus (C-3), along with residential and small business uses (C-4), and the publicly owned Tollgate Farm open space (C-5) along the west bank. The comprehensive plan and zoning map indicate that planned future land uses include neighborhood business and Employment Park along the west bank with park and open space use on the publicly owned Tollgate property. The east bank is designated downtown commercial, low-density residential, and park/open space/public facilities along the wastewater treatment plant /Tollgate site. The riverbank levee trails in areas C-2 and C-5 and much of area C-1are in public ownership. There is a public access easement on the Nintendo levee covering most of Section C-3. Current impervious surface is calculated at approximately 12 percent, indicating the potential for an increase in impervious surface under current land use projections.

Critical Resource Areas

Between the Nintendo campus and the shoreline, remnant riparian forest along Ribary Creek parallels the west bank of the South Fork. Dominant tree species include black cottonwood interspersed with alder. Approximately 27 acres of forested, riverine, and emergent wetland is also present in this segment. The remnant forest and wetland habitat provides forage, perch and limited nesting opportunities for wildlife. Ribary Creek offers an important wildlife corridor, linking Rattlesnake Ridge habitat to the South Fork Snoqualmie River and to Three Forks Natural Area to the north. Ribary Creek and the associated riparian wetlands provide water, food, and cover for wildlife.

Several riparian wetlands associated with the South Fork Snoqualmie River and Ribary Creek were identified in the shoreline jurisdiction in this segment. Ribary Creek drains the steep slopes of Rattlesnake Mountain, south of the City and has a watershed of approximately 840 acres. Ribary Creek also receives runoff from a portion of the Forster Woods residential development, an area south of I-90, and an outlet mall north of I-90. Storm drainage facilities are designed to detain runoff from these areas prior to discharging to the stream. The small drainage entering the South Fork on the east bank near the wastewater treatment facility is the outlet for most of the storm drainage in the downtown area north of North Bend Way. A small drainage entering the South Fork between North Bend Way and the Tanner Trail is the storm drainage outlet for most of the in the downtown area south of North Bend Way.

Habitat Limiting Factors

Very little sediment deposition occurs between the Snoqualmie Valley Trail bridge and the Bendigo Boulevard South crossing due to the relatively straight, and confined nature of this reach (URS Greiner Woodward Clyde, 2000). The riparian corridor in Segment C is a 25-to100-foot wide early successional/mixed age stand dominated by cottonwood. A limiting factor in this segment may include gravel removal operations upstream. Ribary Creek flows year round and is a fish-bearing stream.

Opportunity Areas

Opportunity Area C-1 ***(Conservation, Rehabilitation, Restoration)***

Area C-1, shown on **Figure 11** in Appendix A, is an area of second-growth mixed forest, consisting predominantly of coniferous species, including several large spruce, as well as western hemlock, Douglas fir, cherry, several large red alder, large black cottonwood, red-osier dogwood. Remnant wetland channels occur throughout, and the area is at several feet lower grade than the dike. Area C-1 contains wetlands as well as remnant riparian-forested areas, and offers opportunities to preserve the wooded area, to remove invasive species and enhance public access to the river. It may be possible to work with King County to reconnect the river channel to more of its floodplain by modifying or setting back the levee to increase flood storage and conveyance capacity. This would allow for the creation of side channel habitat where fish could take refuge from high velocity flows in the main river channel. Pursuit of a setback levee in this section would involve coordinating with multiple small property owners and would be most

likely to happen as part of a flood hazard reduction project along the South Fork to better protect the downtown area.

Opportunity Area C-2 (Conservation, Rehabilitation, Restoration)

Area C-2, is shown on **Figure 11** in Appendix A. This City and County owned land (part of the Tollgate Farm) along the length of the east bank of the South Fork offers opportunities for habitat conservation and restoration. This area is similar to the area described above but it is publicly owned. It is an area of second growth mixed forest adjacent to the City wastewater treatment facility. It may be possible to enhance the wetlands adjacent to the wastewater treatment plant and use them to better treat the storm water from downtown before it enters the River. It may also be possible to better treat discharge from the plant before it enters the River on the same wetland property.

Opportunity Area C-3 ***(Conservation, Rehabilitation, Restoration)***

Area C-3, is shown on **Figure 11** in Appendix A. Ribary Creek follows the historic river channel and floodway of the South Fork downstream of South Fork Avenue (South Fork Tributaries Action Plan, 2001). Ribary Creek and the associated riparian forest in shoreline jurisdiction offers significant wildlife habitat, providing water, food, and cover. This area has been identified for potential Conservation of riparian habitat for wildlife species and resident rainbow and cutthroat trout, as well as improving water quality downstream. Potential exists for the removal of invasive species and planting of native trees and shrubs. Ribary Creek is known to overflow its banks in area C-3. The South Fork Tributaries Action Plan (2001) recommended several alternate berm alignments near the Nintendo site. If the levee were modified in this area, side channel habitat would be increased along the South Fork, a connection would be established between historical floodplain wetlands and the South Fork, and Ribary Creek overflow and flooding to the west may be alleviated. Modification of the levee in this area may be possible through working with King County and Nintendo as part of a future plan for flood hazard reduction along the South Fork. Flood hazard reduction could better protect the adjoining property (and downtown), convey water from west bank levee overtopping upstream of Bendigo Boulevard, and increase flood storage capacity.

Opportunity Area C-4 ***(Conservation, Rehabilitation)***

Area C-4, shown on **Figure 11** in Appendix A, includes a mixed forest area along the west bank. Working with King County, there are opportunities to remove invasive species and to set back or lower the levee, creating side channel habitat along the South Fork and connecting the riparian corridor of Ribary Creek and the South Fork. Pursuit of a set back or lowered levee in this section would involve coordinating with multiple small property owners lying between the Tollgate property owned by the City of North Bend and fronting NW 8th Street and the South Fork of the Snoqualmie River.

Opportunity Area C-5 (Rehabilitation, Restoration)

Area C-5, is shown on **Figure 11** in Appendix A. This includes a pasture area along the west bank of the South Fork. Area C-5 is part of the County owned section of Tollgate Farm, open

space land containing two wetland areas that extend into the 200-foot shoreline jurisdiction. Potential habitat enhancement opportunities include the removal of invasive plants such as Himalayan blackberry and Scot's broom, combined with the planting of trees and shrubs to restore riparian cover, reduce erosion along the river bank, and improve nesting and forage habitat. Working with King County, wetlands in the Tollgate portion Area C-5 could be fully delineated, removed from pasture status and restored with corridors connected to Ribary Creek. Low lying floodway portions of Area C-5 may offer the potential for reconnection to the South Fork of the Snoqualmie River in a combined flood storage and habitat enhancement project by setting back or modifying the levee. This could enhance flood protection for the essential public wastewater treatment facility across the River in Area C-2.

6.4 Segment D – Bendigo Boulevard Bridge Upstream to City Limits

Summary: Extending south from the Bendigo Boulevard bridge crossing, upstream to the south City limits (RM 2.8 to Rm 4.0), this segment includes the east side of the river only, with the exception of the Bendigo Boulevard crossing vicinity. This segment is constrained by dikes and dominated by residential use. The Maloney Grove tributaries flow through a forested tract and enter the South Fork Snoqualmie River in this segment. No wetlands have been identified in the shoreline jurisdiction in Segment D.

Current Land Use

Land use in Segment D is predominantly single and multi-family residential. The comprehensive plan and zoning map indicate future land use as interchange commercial along the west bank, and high density residential, low density residential, and park/open space along the east bank. Current impervious surface is calculated at approximately 18 percent, with a future increase in impervious surface expected to occur under current land use projections.

Critical Resource Areas

The South Fork Snoqualmie River channel is braided in this segment, and is diked along both banks. Several gravel bars occur in the river channel, vegetated in places with black cottonwood and willow species. Along the east bank is an approximately 10-foot-wide mixed corridor of red alder and western redcedar, with an understory of sword fern, Himalayan blackberry, and Scot's

broom. The upstream section of the adjacent housing development is separated from the levee by a corridor of open space, whereas the more established residential area to the north is developed immediately adjacent to the levee. A small section of the west bank falls in the City limits for this segment. This is a forested tract adjacent to Bendigo Boulevard and vegetated with immature trees, predominantly red alder, as well as Douglas fir and black cottonwood, with an understory of salmonberry.

A patch second growth, mixed forest extends south and east beyond the shoreline jurisdiction along the east bank. A diverse range of tree species including western hemlock, black cottonwood, red alder, and Douglas fir, as well as several snags, were noted in this area. Several drainages, referred to as the Maloney Grove tributaries (R.W. Beck, 2000) flow to the east bank of the South Fork in this segment. Several vegetated swales were noted crossing in the adjacent residential development. Clough Creek flows from Rattlesnake Ridge and enters the west bank of the South Fork just outside of the City limits.

Habitat Limiting Factors

Gravel bars are present upstream of the Bendigo Boulevard South crossing, although levees are present (URS Greiner Woodward Clyde, 2000). A study by King County revealed that very little of the significant sediment load carried by the South Fork deposits in reaches of the Snoqualmie River near downtown North Bend (Booth et al., 1991). Most is deposited in Segment A described above, as well as in this segment. Between 1956 and recent years, gravel has been removed at a major gravel bar between I-90 and Bendigo Boulevard South. Approximately 1,200 cubic yards have been removed per year (URS Greiner, 2000).

Limiting factors in this segment include roads and development, which fragment habitat and encroach into the shoreline. Public access is available for approximately 50 percent of this segment, along the levee and in park areas. The most significant factor in this segment is the conversion of riparian habitat to residential land use and the corresponding increase in impervious surface. Riparian vegetation in this segment is limited for 50 percent of the shoreline, with a very narrow strip of vegetation paralleling the existing residential development. Native shrubs and non-native Himalayan blackberry also line the riverbanks.

Opportunity Areas

Opportunity Area D-1 ***(Conservation, Rehabilitation, Restoration)***

In area D-1, shown on **Figure 12** in Appendix A, there are several opportunities to improve shoreline cover of native plants to increase shoreline stability and habitat diversity. The forested area could be improved by planting mixed-age, mixed tree species, including coniferous trees. Enhancement work would need to be coordinated with King County and the existing public trail easement on the levee.

Opportunity Area D-2 ***(Rehabilitation)***

Area D-2, shown on **Figure 12** in Appendix A, includes the banks of the South Fork where the development is set back from the levee, in the new Si View subdivision. Planting of trees and

shrubs in this area would restore riparian cover along the levee and improve bird foraging and cover habitat. Enhancement work would need to be coordinated with King County and the existing public trail easement on the levee.

Opportunity Area D-3 ***(Rehabilitation)***

Area D-3, shown on **Figure 12** in Appendix A, includes the banks of the South Fork where land is developed up to the edge of the levee. Planting of trees and shrubs in this area would restore riparian cover along the levee and improve bird foraging and cover habitat. Enhancement work would need to be coordinated with King County and the private property owner. Public access to the levee could be acquired working with the property owner to connect the existing public trail easement on D-4 with the Si View County Park property located the levee immediately south of D-3.

Opportunity Area D-4 ***(Conservation, Rehabilitation)***

Area D-4, shown on **Figure 12** in Appendix A, is a forested tract along the east bank of the South Fork, just south of Bendigo Boulevard in public park ownership. Planting of mixed-age, mixed tree species, including coniferous trees, would increase shoreline stability and habitat diversity in this area. Enhancement work would need to be coordinated with King County and the existing public trail easement on the levee.

Opportunity Area D-5 ***(Conservation, Rehabilitation)***

Area D-5, is shown on **Figure 12** in Appendix A. This forested area along the west bank of the South Fork, just south of Bendigo Boulevard, is known to receive overbank flow from the South Fork during flood events. The *South Fork Tributaries Action Plan Phase II Report* recommends investigating the feasibility of levee improvements throughout Segment D, to keep South Fork Snoqualmie flows from overtopping into the Shamrock Park/Berry Estates. The report states that levee improvement would reduce flooding along Gardiner Creek (reducing flood levels more than four feet in some areas), and on Ribary Creek at NW 8th Street by up to one foot. King County, working with the City of North Bend, is examining the possibility of securing U.S. Army Corps of Engineers funding to set back the levee in section D-5 as a flood reduction measure. Companion efforts are underway with the Washington State Department of Transportation to provide conveyance for floodwaters under Bendigo Boulevard. To date, neither project has been funded.

6.5 Summary of Conditions and Opportunity Areas in Maximum Shoreline Jurisdiction (Floodplains)

As previously discussed, areas of mapped 100-year floodplain in North Bend cover large portions of the City, including the downtown areas as well as residential areas east of the South Fork. Floodplain areas to the west of the South Fork are a combination of existing and proposed employment park uses and open space.

Given the large area of the City's floodplain, there are several opportunities and constraints to enhancing and restoring ecological function related to shorelines. East of the river, opportunities

to restore floodplain ecological functions are limited by existing development. Much of this floodplain area, particularly in southern portions of the City, has been built out, and there are few identified significant habitat areas or wetlands. Floodplain areas to the north of downtown and east of the river are largely conserved in open space. While there are opportunities for wetland and stream conservation and enhancement west of the City's shoreline jurisdiction, many of these opportunities relate to stream and wetland enhancement, as opposed to restoration of historic channel migration areas. These opportunities may be more appropriately addressed through the City's critical area regulations or flood hazard reduction plans and regulations.

6.6 Cumulative Impacts

On a basinwide scale, activities in North Bend's shoreline jurisdiction contribute to past, present, and future opportunities and constraints for the maintenance and long-term recovery of ecological conditions and fish and wildlife habitat. As discussed in previous sections, the South Fork Snoqualmie River basin has been subject to a series of activities and actions over time, including river channelization, timber harvest, agricultural activities, and urban development. In the City of North Bend, population is projected to increase to 11,229 by the year 2014; land area is expected to double to approximately 7 square miles. Collectively, these activities will likely alter basin conditions that contribute to ecological functions. However, the City has also protected several areas of the shoreline in open space, offering significant opportunity to cumulatively enhance and restore shoreline ecological functions over time. Upon development of updated shoreline policies and regulations, the City should conduct an evaluation of cumulative impacts to examine the implications to basinwide conditions of full buildout of the City's shoreline jurisdiction.

7.0 FINDINGS AND RECOMMENDATIONS

The following recommendations synthesize the area-specific opportunities identified in Section 6 above and provide additional shoreline management recommendations in the context of other local and regional planning activities. These recommendations are intended to frame the future revision of the City's shoreline master program by identifying opportunities for ecological conservation, enhancement, and restoration.

7.1 Conservation Findings/Recommendations

- As discussed in Section 6.0, there are several opportunities to remove invasive species and replant existing mixed forest with native trees and shrubs throughout North Bend's shoreline jurisdiction, particularly in riparian corridors. Regulatory and non-regulatory policies unincorporated into the shoreline master program to require or encourage revegetation of these areas by landowners would help improve the habitat values of the shoreline jurisdiction.
- There are also several opportunities for restoration of stream and off-channel habitat, such as the area near the confluence of Gardiner Creek and the South Fork. Adding new items added to the capital improvement program to implement opportunities identified in Section 6, regulatory approaches, or non-regulatory policies in the shoreline master program to require or encourage restoration of these streams would help the City take advantage of these opportunities.
- Protection and restoration of riparian habitat and wetlands could help decrease stream temperatures, control erosion and sedimentation, distribute nutrients and food, and maintain a more natural flow regime (Snohomish Basin Salmon Recovery Forum, 2001).
- North Bend's shorelines offer opportunities to work with King County and adjoining property owners to modify or set back levees to create side-channel habitat, particularly in segment C where off-channel wetlands could be re-connected to the mainstem of the South Fork.
- In other well forested areas of North Bend's shoreline, new policies, regulations, or incentive programs could help conserve and retain native forest vegetation.
- The City of North Bend has protected large areas of open space in its shoreline jurisdiction. These areas offer significant habitat value and opportunities for continued conservation, restoration, and enhancement. These areas, because they are publicly owned, could offer opportunities for larger-scale restoration projects, such as restoring off-channel habitat or replanting native vegetation. These opportunities could take the form of capital improvement projects, mitigation banks for development in the City, transfer of development rights, or coordinated regional partnerships.
- Coordinating shoreline conservation activities with ongoing floodplain management activities would help to coordinate projects so that enhancement of ecological functions could be considered, for example, in levee management plans or flood control projects.
- While the state's Shoreline Management Act allows jurisdictions to manage 100-year floodplains in their shoreline jurisdiction, there appear to be several other potentially

more effective opportunities in North Bend to manage floodplain resources. For example, wetlands and stream corridors in the City's floodplains could be managed under the City's critical areas ordinance and floodplain development regulations, while restoration of off channel areas in floodways would be addressed under the shoreline master program. Inclusion of the City's 100-year floodplain in the shoreline program has the disadvantage that it would likely substantially increase City staff permitting duties since much of the City's downtown and residential areas are located in the floodplain.

- Even with flood hazard management and shoreline management as two distinct City programs, the City could explore opportunities to integrate shoreline management with its Flood Management Plan. For example, compensatory storage projects for floodplains could be coordinated with ecological conservation projects, such as re-connection of off-channel habitat or creation of wetlands.
- Opportunities to restore degraded habitat along Silver Creek, portions of Ribary Creek west of downtown, lower parts of Gardiner Creek and surrounding areas, and channels through downtown (Malony Grove tributaries) are available and could be explored. Restoration could include fish passage in problem culverts on Gardiner Creek and Ribary Creeks.
- Several regulatory and non-regulatory approaches might be incorporated into the City's shoreline policies and regulations, to provide landowners with options such as on-site density transfers, conservation easements, offsite transfer of development rights, and technical assistance for restoration projects.
- Recognizing that the City's shorelines are part of a natural linked greenway system, the City could explore coordination of shoreline conservation and restoration opportunities with neighboring jurisdictions, such as King County and the City of Snoqualmie, as well as tribes and state and federal resource agencies and regional watershed planning efforts.
- For shoreline stabilization projects, demonstration of the need for engineering approaches to shoreline stabilization could be required before approval. The use of bioengineering (such as root wads and replanting) where possible and minimizing new dikes or bank hardening could be encouraged in the City's shoreline master program.

7.2 Recommendations to Address Data Gaps

Habitat data gaps identified in the *Initial Chinook Work Plan* (salmon conservation and planning for the Snohomish Basin), as well as other potential gaps are listed below. While some of these gaps were identified to collect more information relative to habitat needs for chinook salmon, these data needs also apply to habitat needs for other salmonid (including trout) species as well as other fish and wildlife species:

- Document current abundance and function of in-channel conditions such large woody debris (LWD). LWD refers to large logs and rootwads in or on the banks of rivers that fish use to hide and rear. Evaluate potential for LWD recruitment on a basinwide scale.

- Evaluate riparian conditions in agricultural areas to determine their relationship to increased bank erosion.
- Continue to work with regional watershed planning efforts to identify areas that are particularly susceptible to land disturbances, bank erosion, and slope failures.
- Gather more detailed knowledge of historic watershed conditions.
- Continue to track bull trout survey efforts.

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APPENDIX A – FIGURES